Operational Concept for a complete A-SMGCS

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***Abstract* - The basic idea of this paper is to identify a comprehensive A-SMGCS (Advanced Surface Movement Guidance and Control System) concept that allows incorporating the full scope of surveillance, guidance, routing and control services as well as new onboard related A-SMGCS services including their air-ground interoperability. This concept approach supports the stepwise implementation of a complete A-SMGCS at a specific airport with its specific needs. These results are an output of the European project *EMMA* (European Airport Movement Management by A-SMGCS), an Integrated Project launched by the European Commission in its sixth framework programme. The paper identifies all A-SMGCS services, their evolutionary implementation steps, and gives recommendation to the composition of *implementation packages (IP)* to meet the airports' specific needs.**

***Index Terms* - A-SMGCS, operational Concept, EMMA**

I. Introduction

THE basic idea of this paper is to identify a comprehensive A-SMGCS (Advanced Surface Movement Guidance and Control System) concept that allows to incorporate the full scope of surveillance, guidance, routing and control services as well as new onboard related A-SMGCS services including their air-ground interoperability. This concept approach supports the stepwise implementation of a complete A-SMGCS and shall give recommendations for A-SMGCS "implementation packages" that are tailored to the user's needs. These results are an output of several workshops with A-SMGCS users, industry- and R&D organisations who participate in the European project *EMMA* (European Airport Movement Management by A-SMGCS), an Integrated Project launched by the European Commission in its sixth framework programme.

The finally introduced *implementation packages* go beyond the already existing EUROCONTROL, EUROCAE, and ICAO A-SMGCS *implementation level* definitions because they also consider equipment and procedures of a specific service. The new term *packages* has been chosen to distinguish from the term '*implementation level'*, which proved as insufficient in meeting the needs of stakeholders during a stepwise implementation of a full scope A-SMGCS. EUROCONTROL's and EUROCAE's definition with its four implementation levels focuses on the main four A-SMGCS functions: *surveillance, control, guidance,* and *routing*, which works fine with *surveillance* and *control* because these two functions depend on each other logically in a successive way and do not consider the onboard part. Moreover, these two services are mainly used to assist the users, thus procedures do not have to be changed fundamentally, and interoperability to other services is not a critical issue. The implementation of automated routing or guidance services, however, would increase the complexity of the A-SMGCS system and their operational use still lacks maturity. The concept has to give careful consideration on changing operational procedures, shifting responsibilities from human to equipment (e.g. visual reference vs. electronic display), introducing onboard automated services, and equipments, as well as on the interrelations between the A-SMGCS functions.

The EUROCONTROL and EUROCAE level III and level IV concepts do not help here anymore as these concepts do not adequately address the full scope of ASMGC-S operational use. ICAO goes a step further and considers the responsibility shift between controllers, pilots, and equipment for all A-SMGCS services but does not give sufficient information to procedures with which the system is used nor does it describe what technical enablers would be needed and what service performance level the users can expect.

II. EMMA Implementation Steps for A-SMGCS Services

The EMMA operational concept approach commenced to extend EUROCONTROL's level I&II concept [3]-[4] by a detailed description of all A-SMGCS services that include guidance, routing, planning, and onboard services, as well an extensions of surveillance and control services. This has been done for each of the three main users of an A-SMGCS: Air traffic controllers (ATCOs), flight crews, and vehicle drivers. The second step was to look for appropriate technical enablers that are needed to bring the service to live. The third step was to derive successive implementation steps for each A-SMGCS service to provide recommendations for a stepwise implementation. To achieve this, the services and technical enablers have been assessed with respect to their:

- Development status of the technical enabler (e.g. standardised, on the market or to be developed yet)
- Development status of the operational service (e.g. already validated by operational life trials or under investigation through simulation or only at the stage of a concept)
- Degree of interrelations to other functions (in terms of its complexity)
- Quality of the technical enabler (needed reliability)
- Impact on current operational procedures and size of the changes
- Cost/benefit considerations

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The following tables show the implementation steps for each A-SMGCS service that have been identified by the EMMA partners[1] (cf. EMMA OSED document, §2, [1]).

ATCO Service – SURVEILLANCE

Service Steps	Characteristics	Comments
S1	• Detection and accurate position of all aircraft in the manoeuvring area • Detection and accurate position of all vehicles in the manoeuvring area • Detection and accurate position of obstacles in manoeuvring area • Identification of all cooperative aircraft in manoeuvring area • Identification of all cooperative vehicles in manoeuvring area	All movements on the manoeuvring area have to be authorised by aerodrome controller (§7.5.3.2.1 [8]). With EMMA all authorised movements shall be properly equipped to enable automatic identification. All other movements are intruders or obstacles. There might be authorised aircraft on the manoeuvring area that are not properly equipped to be identified automatically (e.g. in case of transponder failure). Procedures to cover such exceptional cases have to be derived.
S2	• Step1 + • Detection and identification of all aircrafts in movement area	There might be authorised aircraft (e.g. VFR) on the movement area that are not properly equipped to be identified automatically. Those aircraft are an exception but procedures have to be derived to cope with those aircraft too.
S3	• Step2 + • Detection and identification of all vehicles in movement area (where manoeuvring aircraft may come into conflict with each other or with vehicles) • Detection of Obstacles in movement area	ICAO [7] §3.5.16.3 "It is not practicable to exercise total control over all traffic on the movement area. On the apron, an A-SMGCS applies only to those areas where manoeuvring aircraft may come into conflict with each other or with vehicles. Therefore, one requirement is to restrict the movement of vehicles on the apron to designated areas and routes. It is also necessary to keep service vehicles away from an active stand. This can be achieved by having painted lines that outline the areas to be left clear when a stand is active. Alternate means of protecting an active stand might become available as a result of technology." Those restrictions to apron areas where manoeuvring aircraft may come into conflict with each other or with vehicles are particularly needed in low visibility conditions, when movements are not able to avoid each other. Movements, which uses those apron areas, should be co-operative to get identified automatically on the ATCO surveillance display and should be equipped with an onboard display showing the own position and position of other aircraft to avoid conflicts.

ATCO Service – CONTROL

Service Steps	Characteristics	Comments
C1	• Runway Conflict/Incursion detection and alerting of: 1. Aircraft arriving to, or departing on, a closed runway; 2. Arriving or departing aircraft with traffic on the runway (including aircraft beyond the runway-holding positions); 3. Arriving or departing aircraft with moving traffic to or on a converging or intersecting runway; 4. Arriving or departing aircraft with opposite direction arrival to the runway; 5. Arriving or departing aircraft with traffic crossing the runway; 6. Arriving or departing aircraft with taxiing traffic approaching the runway (predicted to cross the runway-holding position); 7. Arriving aircraft with traffic in sensitive area (when protected); 8. Aircraft exiting the runway at unintended or non-approved locations 9. Unauthorized traffic approaching the runway; 10. Unidentified traffic approaching the runway 11. Aircraft on a closed taxiway[2]; 12. Aircraft taxiing with excessive speed; 13. Crossing of a lit stop bar;	The conflicts in this step address mainly runway conflicts which are the most critical in safety terms. Conflicts are initially defined by ICAO ([7], §3.4.5.7).
C2	• Taxiway Conflict/Incursion detection and alerting of: 1. Arriving[3] aircraft exiting runway at high speed with converging taxiway traffic; 2. Aircraft approaching stationary traffic; 3. Aircraft overtaking same direction traffic; 4. Aircraft with opposite direction traffic; 5. Aircraft approaching taxiway intersections with converging traffic; 6. Aircraft exiting the taxiway at unintended or non-approved locations; 7. Unauthorized traffic on the taxiways, 8. Unidentified traffic on the taxiways	The conflicts in step 2 address mainly taxiway conflict. Conflicts are initially defined by ICAO ([7], §3.4.5.7).
C3	• Detection of route/plan deviations • Support to Ground Clearances and ATCO coordination	The Support to Ground Clearances and ATCO handover coordination involves Controller Pilot data link Communication (CPDLC) and Electronic Flight Stripes (EFS)

[1] Beside industry and R&D representatives there were representatives from ANSPs (ANS_CR, ENAV, DSNA, AENA, and DFS) and Airlines (CSA and DLH).

[2] Step 1 conflicts 11), 12), and 13) are taxiway conflicts, but because their less complexity EMMA decided to implement them with step 1 already.

[3] ICAO doc. 9830 considers this as a runway conflict

Service Steps	Characteristics	Comments
C4	• Conflict/Incursion detection and alerting of apron/stand/gate conflicts 1. Aircraft movement with conflicting traffic; 2. Aircraft movement with conflicting stationary objects; 3. Aircraft entering/exiting the apron / stand / gate area at unintended or non-approved locations; 4. Unidentified traffic in the apron / stand / gate area.	The conflicts in step 4 address mainly apron/stand/gate conflicts which are the most challenging conflicts in terms of their complexity. Conflicts are initially defined by ICAO ([7], §3.4.5.7). Only the movements in the apron which could be threats to aircrafts movements shall be covered.

Note: The provision of automatic *conflict resolution advisories* may be initiated at any step of the control service depending on the complexity of the resolution possibilities.

ATCO Service – ROUTING

Service Steps	Characteristics	Comments
R1	• Manual Routing	Manual input of a route supported by the computation of the shortest taxi route w.r.t. to local standard routes
R2	• Semi-automatic Routing	Routing service proposes a most suitable route, taking into account control and flight plan information.
R3	• Automatic Routing	Routing service provides route (track) and time information by aid of a planning function.
R4	• Automatic Routing + Optimisation of runway resource[4]	Planning support is further increased by a departure manager providing optimal departure times and sequences. Procedures are supposed to be changed.

ATCO Service – Guidance

Service Steps	Characteristics	Comments
G1	• Manual Operation of Ground based Guidance Means	Equipment available on the market.
G2	• Automatic Operation of Ground based Guidance Means	Automatic generation of guidance information, based on the cleared route and the actual position of the aircraft.

Note: Ground based guidance gives direct visual information to the pilot by viewing outside the cockpit windows, and thus is independent on on-board services. Ground guidance means are not a real service to the ATCO but are operated by her/him – that is the reason why it was grouped under *ATCO services*.

Flight Crew Service – Aircraft

Service Steps	Characteristics	Comments
A1	• Airport Moving Map • Surface Movement Alerting (initial, incl. proximity of obstacles – runway) • Braking and Steering Cue (for landing roll)	Own ship position on a moving airport map including a monitoring and alert service referring fixed obstacles or proximity alerts.
A2	• Ground Traffic Display • CPDLC Ground Clearance and Taxi Route Uplink • Ground-Air Database Upload • Surface Movement Alerting (taxi route deviation) • Traffic Conflict Detection • Braking and Steering Cue (landing roll and taxi)	Own ship position including the indication of the surrounding traffic and a monitoring service to detect surface or traffic conflicts. Airport map upload service to update recent layout changes. Communication is supported by a point to point data link. Taxi routes can be transmitted and represented graphically on the AMM display. Braking and steering cues are extended to taxiways.
A3	• HUD Surface Guidance	A Head Up Display provides the pilot flying with a scene linked outside view, means; her/his outside view is supported by scene linked navigation cues that are presented on a transparent screen in front of her/his cockpit front window.
A4	• Automated Steering	This service can be compared to an auto pilot for taxi operations. The nose wheel is automatically kept on the centre lines, whereas the throttles will be further under control of the pilot flying.

Vehicle Driver Service – Vehicle

Service Steps	Characteristics	Comments
V1	• Airport Moving Map • Surface Movement Alerting (vehicle alone)	Own vehicle position on a moving airport map including a monitoring and alert service referring fixed obstacles infringements into restrictions areas.
V2	• Surface Movement Alerting (complete) • Ground Traffic Display Traffic Conflict Detection	Own ship position including the indication of the surrounding traffic and a monitoring service to detect surface or traffic conflicts.
V3	• Dispatch and Guidance by data link	Communication is supported by a data link. Information or Taxi routes can be transmitted and represented graphically on the AMM display.

III. From Service Steps to Implementation Packages

Having defined implementation steps for each A-SMGCS service the next step was to give recommendations to the stakeholders how to group them to *implementation packages* (IPs). Not all combinations, however, are feasible. Therefore, the services and their technical enablers cannot be considered in isolation. The services interact and thus depend on each other. For instance, there is no sense in implementing a *route deviation monitoring* service when the taxi route is not known to the *conflict monitoring* service, thus, a routing function has to be implemented first.

Table I attempts to depict the arrangement of implementation steps for each A-SMGCS service in a logical order. The services are arranged to the main users and are identical to the introduced service steps above.

[4] Planning services, like a DMAN, may also be implemented without a pre-existing “routing” function.

TABLE I
LOGICAL INTERDEPENDENCIES BETWEEN EMMA SERVICE STEPS

		Expected Steps to each Service					
ATCO	Surveil.	S1 id/pos everything on RWYs	S2 S1 + id/pos a/c in the complete movement area	S3 S2 + id/pos vehicles movement area			
ATCO	Control		C1 Conflict RWY	C2 Conflict TWY	C3 Conflict Route Deviation / CPDLC / EFS	C4 Conflict Apron	
ATCO	Guidance	G1 Manual switched ground guidance	G2 Auto switch				
ATCO	Routing		R1 Manual	R2 Semi-auto	R3 Auto (planning)	R4 ROP	
Flight Crew	Aircraft		A1 AMM	A2 Ground traffic / CPDLC	A3 HUD	A4 Auto steering	
Vehicle Driver	Vehicle	V1 AMM	V2 Ground Traffic	V3 CPDLC			
Timeline		2006 → (t)					

id	Identification
pos	Position
veh	Vehicle
ROP	Runway Occupancy Planning
AMM	Airport Moving Map
HUD	Head-Up Display
S1	Surveillance Service for ATCOs step 1
C1	Control Service for ATCOs step 1
G1	Ground guidance means Service for ATCOs step 1
R1	Routing Service for ATCOs step 1
A1	Onboard Services for Flight Crews step 1
V1	Onboard Service for Vehicle Drivers step 1

Clustering A-SMGCS service steps to implementation packages must take into account the airport specific characteristics. The ICAO Manual for A-SMGCS proposes three main criteria to classify aerodromes [1]: 1) complexity of the airport layout (basic, simple, complex), 2) the visibility conditions (VIS1 through VIS4), and 3) the average traffic density (low, medium, heavy). A full combination provides 3x4x3 = 36 aerodrome types, which is a large number and thus of little practical use.

To make this huge number of combinations more tangible, EMMA project partners decided to focus on *complex* airports with either *medium* or *heavy* traffic density and four categories of the prevailing visibility conditiontable II), which was deemed much more practical.

TABLE II
IMPLEMENTATION PACKAGE RAW-MATRIX

Layout	Traffic density	Visibility			
		Vis 1	Vis 2	Vis 3	Vis 4
COMPLEX	Medium	Implementation Package (IP) 1	IP2	IP3	IP4
COMPLEX	Heavy	IP5	IP6	IP7	IP8

Each of these eight cells provides a different airport environment and different requirements to fulfil the users' needs. But what are the general users' needs? In principle all potential A-SMGCS users aim to operate safer and more efficient on the ground. This is also reflected in the A-SMGCS definition: *A system providing routing, guidance and surveillance for the control of aircraft and vehicles in order to maintain the declared surface movement rate under all weather conditions within the aerodrome visibility operational level (AVOL) while maintaining the required level of safety* [1]. That means, the two main questions when defining implementation packages at each cell must be: *Which A-SMGCS service is needed to enable safe and efficient ground operations?*

But before this question can be answered satisfactorily, well designed operating procedures have to be developed to enable a service to provide its operational benefit. For instance, when ATCOs are assisted by an A-SMGCS *surveillance and monitoring/alerting* services but they are not allowed to use such services as a primary source of information through relevant operational procedures, safety and efficiency aspects would not fully exploited.

The same applies to planning or onboard guidance: Introduction of these services apart from the right procedures to influence the ground traffic would not lead to throughput benefits. The equipment, on the other hand, is more seen as a catalyst or as a prerequisite to evoke a potential service. But procedures are always the core to enable a service that meets the users' needs.

Initial procedures developed in EMMA are outlined in the D135 EMMA Operational Requirement Document [2]. These initial procedures for higher A-SMGCS services still lack sufficient maturity but were used as a starting point to form EMMA implementation packages. In successor projects (e.g. EMMA2) these procedures will be tested in simulation exercises and updated by the gained results.

IV. IMPLEMENTATION PACKAGES

The following sections describe each of the eight IPs and explain the reasons why certain services are recommended to be implemented. In addition to that, *options* for additional service implementations are proposed for each IP to further increase safety and efficiency.

A. Implementation Package 1

Concerning table II this IP is recommended for a complex airport (more than one RWY) with medium traffic density (20 < movements/h < 35) operating under visibility 1 (VIS1). That is, the ATCO can control the traffic by visual reference over the complete aerodrome, at all times, and the traffic is not as heavy as the ATCOs or pilots reach their mental capacity limits.
A-SMGCS could help here to provide surveillance (position and identification = S1) of aircraft and vehicles on the airport manoeuvring area to enhance ATCO's situation awareness, to complete ATCOs situation assessment (e.g. who is who in a taxi queue far away from the control tower or to allow them to go without pilot position reports). Furthermore, a runway safety net (C1) helps to prevent runway incursions. All this would contribute to safety and efficiency.

Optional: Since an Airport Moving Map (AMM) with its basic service (showing the position on the ground) is independent on ground equipage, Airlines and Airports could equip their aircraft and vehicle fleets with an AMM (A1 + V1) to increase the pilot's and driver's situation awareness what would increase safety again. Automatic routing or ROP (R3/R4[5]) could be initiated when the surface movements are identified as too inefficient compared to runway or gate capacity. When the route is known to the system it can be transferred onboard via data link provided that aircraft support a CPDLC service (A2) and provided that an input device for the ATCO and proper procedures are available.

B. Implementation Package 2[6]

The side conditions with IP2 are the same as with IP1 except that VIS2 is predominating now, i.e. the ATCO cannot see the traffic outside. Therefore, the ATCO[7] should be provided with a surveillance that covers the complete movement area with position and identification information of all aircraft (S2). Since pilots and vehicle drivers can still see and avoid each other (visibility 2), conflict alerting service is concentrated on the runways (C1) where providing separation is the most difficult and safety-critical part.

Optional: A Ground Traffic display showing the surrounding traffic by receiving TIS-B information (A2 + V2) would be an option to increase safety. As surveillance covers the whole airport also conflict alerting extended to the taxiway could be implemented (C2). However, detection of conflicts on taxiways by automation is a very complex task because much information has to be known to the control function, e.g. the cleared taxi route. That is why, it is assumed that *see and be seen* seems to be rather efficient with VIS2. When the route is known to A-SMGCS, CPDLC (A2) can be implemented as well to increase safety and efficiency.

[5] Manual (R1) and semi-automatic (R2) routing are identified as implementation steps and are certainly needed to evolve automatic routing (R3) at an airport. However, working with R1 and R2 are rated as too inefficient to support the ATCOs – therefore these first implementation steps are not considered with A-SMGCS implementation packages.

[6] IP2 nearly complies with EUROCONTROL implementation levels I&II.

[7] At some airports there is a separate Apron or Ramp Control that are not ANSP. However, within this context the ATCO term is also used for non-ANSP control units.

C. Implementation Package 3

Visibility decreases further so that pilots are not able to see and avoid each other anymore (visibility 3). Conditional taxi clearances (e.g. "follow CSA123") that base on the pilots ability to see and avoid the other traffic cannot be applied anymore. Currently ATCOs take into account these new limitations and give taxi instruction following procedural control operations (one aircraft only within a segmented area). Those procedures for low visibility operations (LVO) (PANS ATM, doc4444, §7.10, [8]) maintain safety (as the topmost objective) but on the expense of throughput.

A solution to maintain safety <u>and</u> throughput would be that aircraft are still able to see and avoid each other by providing them a step 2 onboard service (A2). A2 enables them to see the surrounding traffic by receiving surveillance information from ground stations (Ground traffic display enabled by ADS-B-in and TIS-B). The main issue with this solution is the transition phase: It would be needed that all movements are equipped with this service because non-equipped movements cannot avoid other ones and they cannot be controlled in a mixed mode environment. Even when A2 would be the best solution it cannot be assumed that all aircraft are equipped from one day to the next. That is why this solution cannot be preferred for the near future.

A first interim solution would be to assist the <u>ATCO</u> to provide the control service for all movements on the movement area. The runway safety net (C1) would be extended to the taxiways and aprons (C2 + C4) including a route deviation alerting service (C3). To make the route known to the system, automatic routing should be available (R3). Surveillance would be extended to step 3 (S3), what would enable the ATCO to provide traffic information to aircraft and vehicles on the apron area as well. But as control of the whole apron area would be hard to achieve on the basis of its surveillance display, the ATCO would only be responsible for designated areas of the apron area (taxi lanes, active stands, passive stands). Only authorised movements (vehicles must be equipped and must ask for permission to enter) would be permitted to use such areas. Other movements would be restricted to parts of those areas (ICAO doc 9830, §3.5.16.3 [1]).

A second and perhaps more likely interim solution would be to equip vehicles, which have to move on these designated areas, with a ground traffic display (V2). This would enable them to avoid conflicts with moving aircraft and they could move uncontrolled - without regard of the ATCO. Which solution will eventually be applied is highly dependent on the airport layout, equipment reliability and standards, local procedures, and decisions met by the local stakeholders.

Optional: Since S2 is available (includes TIS-B) a ground traffic display (A2) could be used by the airlines to increase situation awareness and efficiency of taxi movements. Routing can be extended to a *runway occupancy planning* (ROP) (R4) when cost/benefit data support this implementation.

D. Implementation Package 4

Visibility is now insufficient to taxi by visual reference. Onboard service has to be extended to step 3 (A3) that includes a head-up display (HUD) that enhances the pilot's local situation awareness by a HUD that provides scene-linked and conformal symbology to enhance the outside view. Step 2 surveillance (S2) and step 2 control (C2) assist the ATCOs and provide them the required situation awareness. Vehicles are equipped with ground traffic displays (V2) whereby they can move without additional traffic information from ATCO.

Optional:
Service to flight crews can be extended by an auto steering function (A4), which keeps the aircraft's nose wheel on the yellow taxi line automatically. Additionally, alerting can be extended to the apron area (C4) and automatic routing (R3) and ROP (R4) can be implemented if shortages with safety or efficiency are found.

E. Implementation Package 5 through 8

IP5 through IP8 are designed for the operational needs of complex airports with heavy traffic density, greater than 35 movements per hour. Since the traffic density is very high and thus the human operators often reach their capacity limits, surveillance should always be step 2 (S2) and control should always be step 3 (C3). These service steps would provide the ATCO with a complete surveillance and a safety net of the overall movement area. This increases mainly safety. To increase or maintain throughput automatic routing including a ROP (R4) should be implemented to support the users by optimised and negotiated times and taxi routes (on a CDM basis).

With VIS3 (IP7) it is insufficient for pilots to avoid collisions with other traffic by visual reference. As mentioned above with IP3 the ATCO should be provided with an additional safety net that detects conflicts not only on the runways and on the taxiways but also on the apron areas (C4). Vehicles moving on the designated apron areas (where they can conflict with aircraft) should be equipped with a ground traffic display (V2) to enable the vehicle drivers to see the surrounding traffic and to avoid it.

With VIS4 (IP8) it is insufficient for pilots to taxi by visual guidance only. As with IP4, the onboard service has to be extended to step 3 (A3) that includes a head-up display (HUD) with enhanced symbology to improve the pilot's local situation awareness.

Optional:
Optional but very beneficial with all IPs with heavy traffic would be the step 2 onboard service to flight crew and vehicle drivers (A2 and V2). With this service pilots and vehicle drivers are always able to see where they are, where they have to go, and where the surrounding traffic is. Particularly with dense traffic, this would contribute to safety, but also to faster taxiing what is an efficiency aspect. Vehicles can be equipped further on with vehicles service step 3 (V3) what would allow them to receive a taxi route, or the exact location of an accident, or other information via data link. This would be particularly beneficial with VIS3 and VIS4 when they cannot see the destination just by looking outside their windows. Table III gives an overview of all eight implementation packages:

TABLE III
RECOMMENDED IMPLEMENTATION PACKAGES

Layout	Traffic density		Visibility			
			Vis 1	Vis 2	Vis 3	Vis 4
COMPLEX	Medium	Recommended	IP1 S1+C1	IP2 S2+C1	IP3 S2+C3/4 +V2+R3	IP4 S2+C2+ A3 + V2
		optional	A1+V1 R3/R4+A2+ V1	A2+V2 C2+R3/R4+A2 +V1	R4+A2	C4+ A4+R3/R4
	Heavy	Recommended	IP5 S2+C3+ R4	IP6 S2+C3+ R4	IP7 S2+C4+ V2+R4	IP8 S2+C3+ A3+V2+ R4
		optional	A2 + V2	A2 + V2	A2 + V3	A4 + V3

V. CONCLUSION

The present paper outlines an improved concept to support future A-SMGCS research and implementations. The concept bases on gained results and experiences from 15 years of A-SMGCS research, e.g. BETA project results ([9], [10], and [11]). This paper does not aim to provide results or even a CBA. It is more focused on giving a theoretical basis for future A-SMGCS research in order to derive reasonable hypotheses and significant results.

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