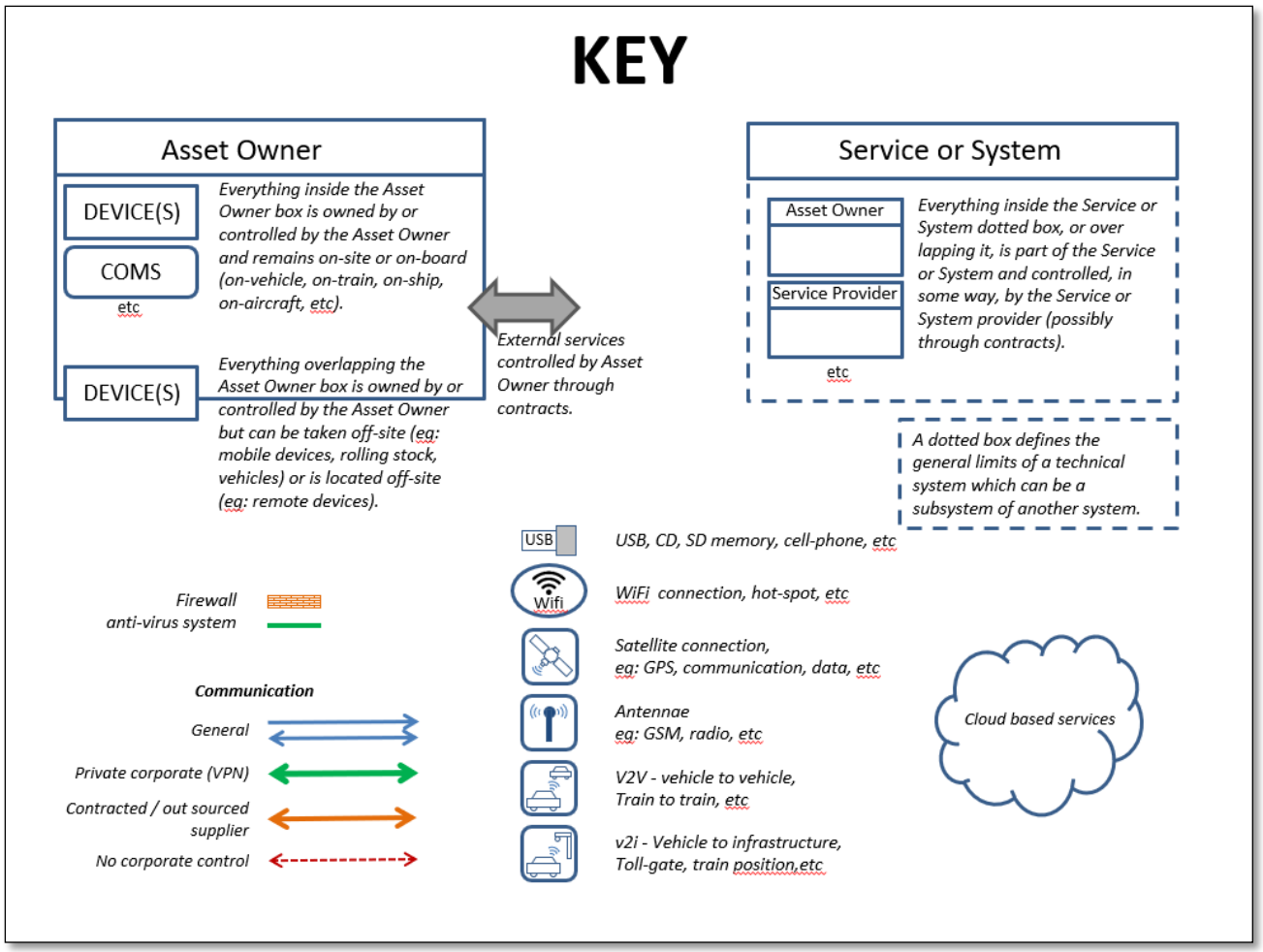
Annex C

Examples of the Generic Matrix Model used in different application sectors

System Diagram Key

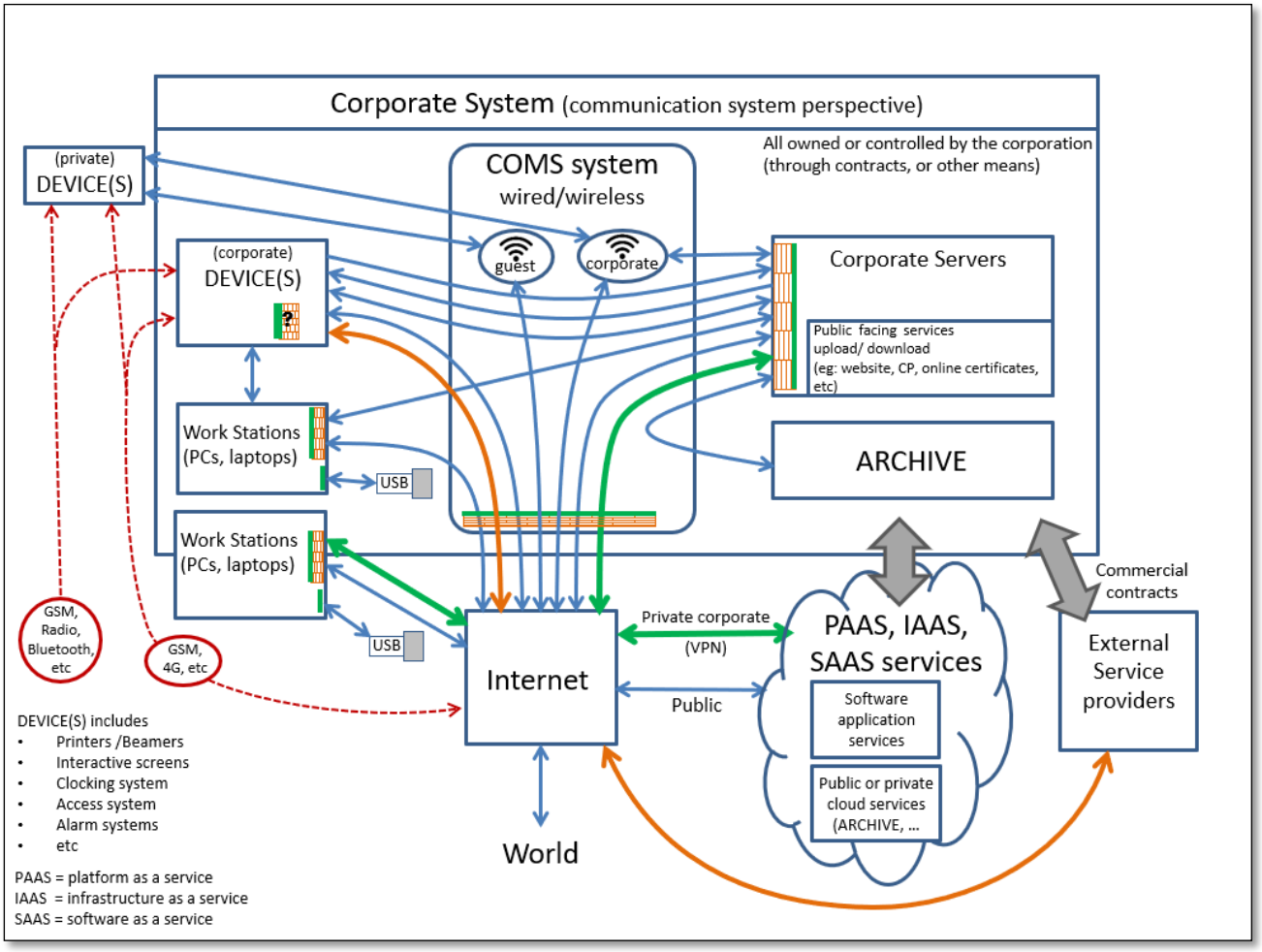
The system diagrams in the examples that follow, will used the elements indicated in the key diagram give here.



The system diagrams that follow are generic representations of the respective sector systems. Specific systems within a particular sector may deviate from the given generic representation but will nevertheless have a close resemblance. The generic representations will cover most of the specific systems in the respective sectors. The goal of these system diagrams is to stimulate the thought process about specific systems, their components, systems design, systems operation, maintenance and management, people qualifications and processes, and so on. An additional value that can be obtained from a review of these system diagrams across a wide range of sectors is the realisation that the differences between different sectors is quite small and that the cybersecurity challenges and the cybersecurity threats that they all face are all very similar.

Corporate System

A typical corporate system will have corporate servers connected through a corporate communication system to corporate devices and workstations, PCs, laptops and so on. This corporate system will also be connected to the internet and use cloud services. The corporate laptops and other communication devices will sometimes operate remotely and communicate with the corporate server via the internet. Memory storage devices, such as USB sticks, will sometimes be connected to corporate devices. External service providers will also interact with devices within the corporate system via the internet sometimes using VPN connections, and non-corporate devices will also be connected to corporate communication systems with access to the internet. Then of course there will be access issues for corporate employees, such as the use of passwords and identification, etc, and the similar issue of physical access by outsourced service personnel, and so on.

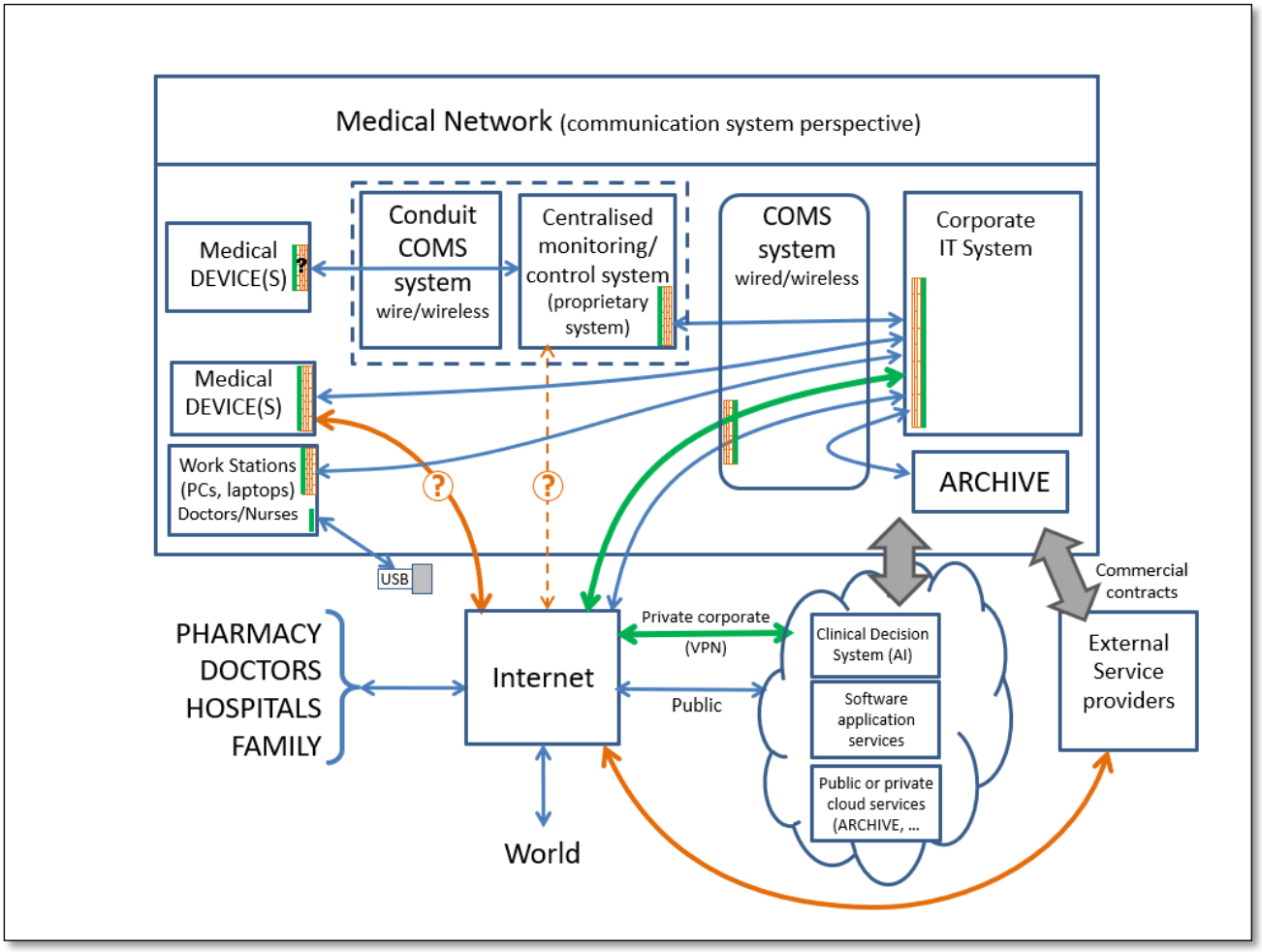


Corporate System GMM in table format. (incomplete)

SYSTEM		General	Objects of conformity		
Activities	Who		Products (components/technolgy)	People	Processes
Components					
Systems components development	Component producers Asset Owners	IEC 62443-0-3 gap assessment IEC 62443-1-1 terminology concepts and models IEC 62443-1-2 master glossary of terms and abbreviations IEC 62443-1-3 systems security compliance metrics IEC 62443-1-4 IACS security and lifecycle user cases ISO/IEC 15408 Common Criteria for information Technology Security Evaluation ISO/IEC 27000 Overview and vocabulary ISO/IEC 27001 Requirements	IEC 62443-4-2 Technical security requirments for IACS components		IEC 62443-4-1 Product Development Requirements
Systems components manufacturing	Component producers Asset Owners		Specific product standards with technical (functional and performance) requirements. (Endpoint device security by design.)		
Interconnections					
System intergration design	Systems designers Asset Owners		IEC 62443-3-3 System security requirements & Security Levels		IEC 62443-2-2 System design IACS Protection levels IEC 62443-2-4 Requirments for IACS solution suppliers IEC 62443-3-2 Suppliers Security risk assessment and
System intergration implementation / realisation	Systems builders Asset Owners				
Interventions					
Security Management System 1. Requirements	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-1 Establishing an IACS security program
2. Implementation / realisation					IEC 62443-1-4 IACS security and lifecycle use cases IEC 62443-2-2 IACS protection levels
3. IACS Risk Assessment	Asset Owner Service provider		IEC 62443-3-3 System security requirements & Security Levels	ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-2 IACS Protection Levels IEC 62443-3-2 Security risk assessment & system design
Security Architecture					
Security Operation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-2 IACS security and
Security solutions	Asset Owner Service provider		IEC 62443-3-1 Security technologies for IACS IEC 62443-3-3 System security requirements & Security Levels	ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-4 Requirements for IACS solution suppliers
1. Patch management implementation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-3 Patch management in the IACS environment

Medical Network System

A typical medical network system will have a corporate IT and communication system (see other example in this section), additionally there will be other proprietary communication systems to specific medical devices. These proprietary systems will use dedicated communication conduits for control and monitoring of devices. There will be other devices controlled and monitored over a common IT communication system. Data will be exchanged with external entities such as other hospitals, doctors, pharmacies, families, medical research organizations, etc. External service providers will also interact with devices within the medical network system via the internet sometimes using VPN connections. There will be access issues for medical network employees, such as the use of passwords and identification, etc, and the similar issue of physical access by outsourced service personnel, and so on.



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Medical Network System GMM in table format. (incomplete)

SYSTEM		General	Objects of conformity		
Activities	Who		Products (components/technolgy)	People	Processes
Components					
Systems components development	Component producers Asset Owners	IEC 62443-0-3 gap assessment IEC 62443-1-1 terminology concepts and models IEC 62443-1-2 master glossary of terms and abbreviations IEC 62443-1-3 systems security compliance metrics IEC 62443-1-4 IACS security and lifecycle user cases ISO/IEC 15408 Common Criteria for information Technology Security Evaluation ISO/IEC 27000 Overview and vocabulary ISO/IEC 27001 Requirements	IEC 62443-4-2 Technical security requirments for IACS components		IEC 62443-4-1 Product Development Requirements
Systems components manufacturing	Component producers Asset Owners		Specific product standards with technical (functional and performance) requirements. (Endpoint device security by design.)		
Interconnections					
System intergration design	Systems designers Asset Owners		IEC 62443-3-3 System security requirements & Security Levels		IEC 62443-2-2 System design IACS Protection levels IEC 62443-2-4 Requirments for IACS solution suppliers IEC 62443-3-2 Suppliers Security risk assessment and
System intergration implementation / realisation	Systems builders Asset Owners				
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2. Implementation / realisation					IEC 62443-1-4 IACS security and lifecycle use cases IEC 62443-2-2 IACS protection levels
3. IACS Risk Assessment	Asset Owner Service provider		IEC 62443-3-3 System security requirements & Security Levels	ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-2 IACS Protection Levels IEC 62443-3-2 Security risk assessment & system design
Security Architecture					
Security Operation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-2 IACS security and
Security solutions	Asset Owner Service provider		IEC 62443-3-1 Security technologies for IACS IEC 62443-3-3 System security requirements & Security Levels	ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-4 Requirements for IACS solution suppliers
1. Patch management implementation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-3 Patch management in the IACS environment

Other standards:

IEC 80001-5-1 Safety, effectiveness and security in the implementation and use of connected medical devices or connected health software --- Part 5: Security - Part 5-1: Activities in the product lifecycle

IEC 60601-4-5 Medical Equipment --- Part 4-5: Guidance and interpretation – Safety related technical security specifications for medical devices → mapped to IEC 62443-4-2

IEC 80001 Application of risk management for IT-networks incorporating medical devices –Part 1: Roles, responsibilities and activities

IEC 80001-2-2 Communicating Security Needs, Risks & Controls (19 Capabilities)

IEC 80001-2-3 Wireless Guidance

IEC 80001-2-4 HDO Implementation Guidance

IEC 80001-2-5 Distributed Alarm Systems

IEC 80001-2-6 Responsibility Agreements

IEC 80001-2-7 Conformance Self-assessment Guidance

IEC 80001-2-8 Mapping Security Controls to the 19 Capabilities of IEC 80001-2-2, NIST 853, ISO/IEC 15408-2 (CC), ISO/IEC 15408-3, IEC 62443-3-3, ISO/IEC 27002.

IEC 80001-2-9 Security Assurance Case for the 19 Capabilities of IEC 80001-2-2

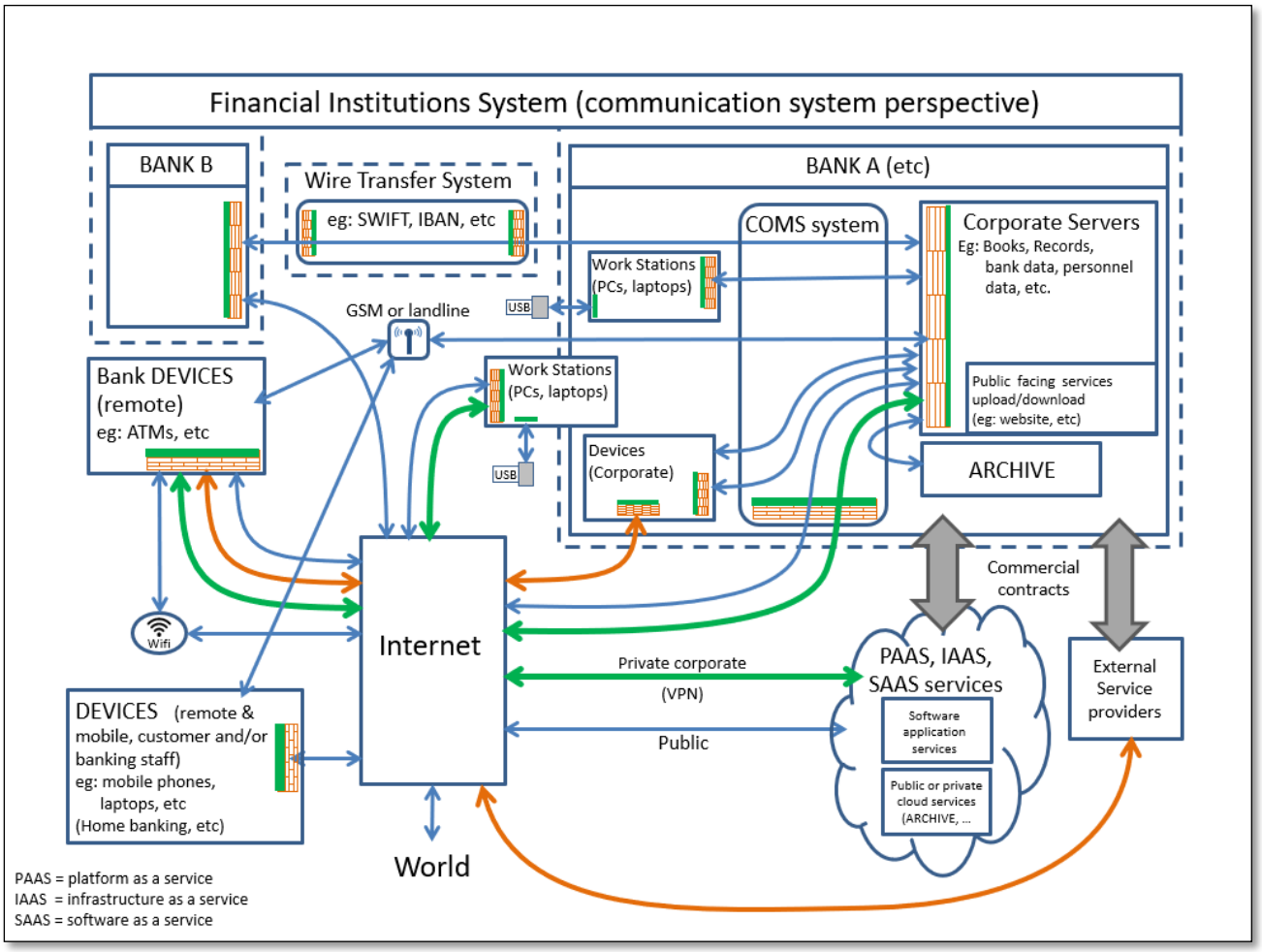
IEC 62304 medical device lifecycle standards ← nothing on cybersecurity

IEC 82304 health software ← small amount on cybersecurity

ISO 14971 application of risk management to medical devices (mostly safety issues)

Banking System

A typical banking system will have a corporate IT and communication system (see other example in this section) and additionally, there are legacy proprietary communications systems for wire transfer to other banks. These proprietary wire transfer systems usually use dedicated communication conduits for such transfers. There are remote devices such as ATMs (cash dispensing devices) which may communicate to the bank via a number of different channels which can include via the telecom system (landline or wireless, GSM, system), or the internet through cables or using a local wifi service (hotspot), and so on. The bank will also communicate with customer's fixed and mobile devices, over the internet and via the telecom system. Banks will also exchange data with external financial ESP service providers (exchange services, payment services, e.g.: credit card service providers, etc). Other external service providers will also interact with devices within the banking system via the internet sometimes using VPN connections. There will be access issues for bank employees, such as the use of passwords and identification, etc, and the similar issue of physical access by outsourced service personnel, and so on.



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Banking System GMM in table format. (incomplete)

SYSTEM		General	Objects of conformity		
Activities	Who		Products (components/technolgy)	People	Processes
Components					
Systems components development	Component producers Asset Owners	IEC 62443-0-3 gap assessment IEC 62443-1-1 terminology concepts and models IEC 62443-1-2 master glossary of terms and abbreviations IEC 62443-1-3 systems security compliance metrics IEC 62443-1-4 IACS security and lifecycle user cases ISO/IEC 15408 Common Criteria for information Technology Security Evaluation ISO/IEC 27000 Overview and vocabulary ISO/IEC 27001 Requirements	IEC 62443-4-2 Technical security requirments for IACS components		IEC 62443-4-1 Product Development Requirements
Systems components manufacturing	Component producers Asset Owners		Specific product standards with technical (functional and performance) requirements. (Endpoint device security by design.)		
Interconnections					
System intergration design	Systems designers Asset Owners		IEC 62443-3-3 System security requirements & Security Levels		IEC 62443-2-2 System design IACS Protection levels IEC 62443-2-4 Requirments for IACS solution suppliers IEC 62443-3-2 Suppliers Security risk assessment and
System intergration implementation / realisation	Systems builders Asset Owners				
Interventions					
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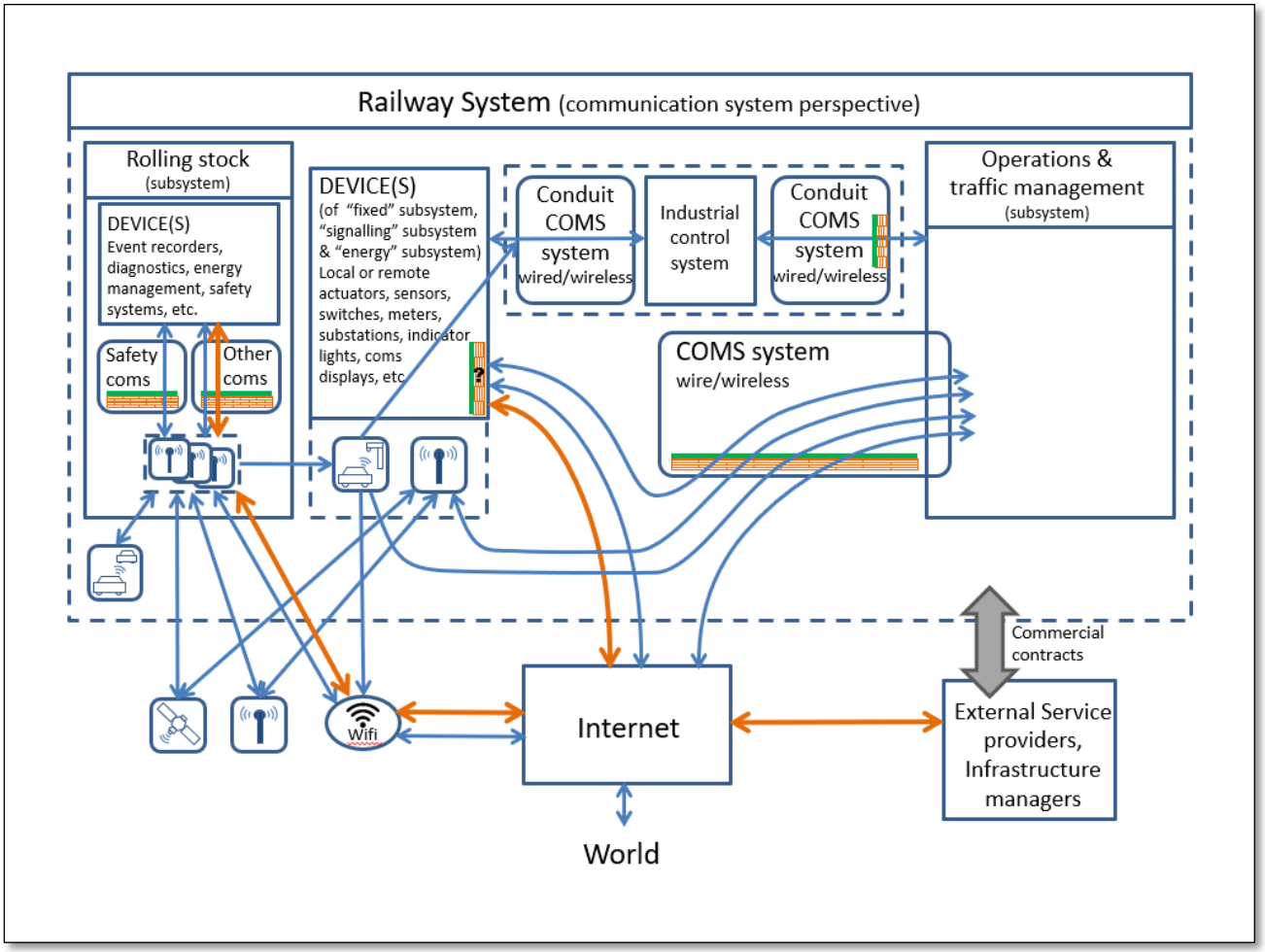
Security Architecture					
Security Operation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-2 IACS security and
Security solutions	Asset Owner Service provider		IEC 62443-3-1 Security technologies for IACS IEC 62443-3-3 System security requirements & Security Levels	ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-4 Requirements for IACS solution suppliers
1. Patch management implementation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-3 Patch management in the IACS environment

Railway System

The railway example was developed on the basis of the European rail system with rollingstock transiting across multiple countries with control responsibility being handed between multiple control centres, energy management centres, signalling centres and so on. A typical railway system has a lot of non-connected legacy infrastructure and a lot of new connected infrastructure with a strong trend towards the latter. A typical railway system has five subsystems being the rolling stock itself, fixed infrastructure such as the tracks, switchgear, overhead lines, railway stations, night depots, etc, an energy control, measurement and billing system, a signalling system and an operations and traffic control management system (ERTMS in Europe). There is much communication between these systems over dedicated proprietary communications systems, over telecom systems, over radio systems, over satellite system, of wifi and internet systems, and so on. There is also train to train communication, train to fixed infrastructure communication and train to controller communication, and so on. There are external service providers and many railways employees with their respective access rights and identification issues. Control of the rail system is divided into cells with lengths of track divide in virtual blocks.



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Railway System GMM in table format. (incomplete)

SYSTEM		General	Objects of conformity		
Activities	Who		Products (components/technolgy)	People	Processes
Components					
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Interconnections					
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System intergration implementation / realisation	Systems builders Asset Owners				
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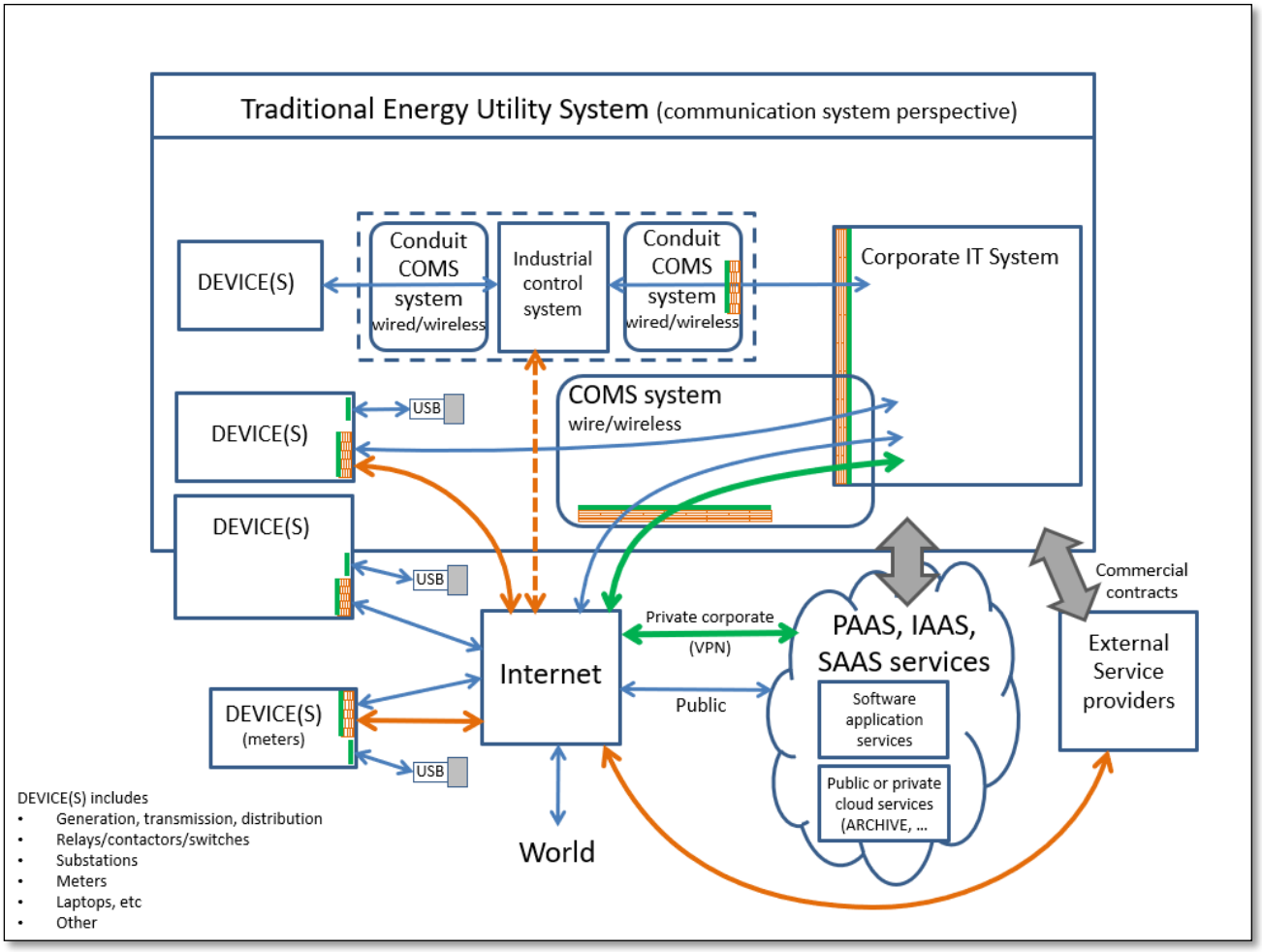
Security solutions	Asset Owner Service provider		IEC 62443-3-1 Security technologies for IACS IEC 62443-3-3 System security requirements & Security Levels	ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-4 Requirements for IACS solution suppliers
1. Patch management implementation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-3 Patch management in the IACS environment

Traditional Energy Utility System

Traditionally an Energy Utility System is a centralised system with a generation system, transmission system and a distribution system. There will be a corporate IT system (see other example in this section) but additionally there will be industrial control systems. These industrial control systems will traditionally use corporate industrial communication conduits for control and monitoring of devices on the different generation, transmission and distribution systems. Some devices will also be controlled and monitored over a common IT communication system. Currently, there is a trend towards the use of public communication systems to monitor and control some remote devices. This trend is being driven by economic factors. Remote devices in the future will therefore be more and more so controlled and monitored using communication over the internet and then to the corporate industrial system and/or the corporate IT system. Memory storage devices, such as USB sticks, will sometimes be connected to corporate devices. External service providers will also interact with devices within the corporate system via the internet sometimes using VPN connections. Then of course there will be access issues for corporate employees, such as the use of passwords and identification, etc, and the similar issue of physical access by outsourced service personnel, and so on.



Traditional Energy Utility System GMM in table format. (incomplete)

SYSTEM		General	Objects of conformity		
Activities	Who		Products (components/technolgy)	People	Processes
Components					
Systems components development	Component producers Asset Owners	IEC 62443-0-3 gap assessment IEC 62443-1-1 terminology concepts and models IEC 62443-1-2 master glossary of terms and abbreviations IEC 62443-1-3 systems security compliance metrics IEC 62443-1-4 IACS security and lifecycle user cases ISO/IEC 15408 Common Criteria for information Technology Security Evaluation ISO/IEC 27000 Overview and vocabulary ISO/IEC 27001 Requirements	IEC 62443-4-2 Technical security requirments for IACS components		IEC 62443-4-1 Product Development Requirements
Systems components manufacturing	Component producers Asset Owners		Specific product standards with technical (functional and performance) requirements. (Endpoint device security by design.)		
Interconnections					
System intergration design	Systems designers Asset Owners		IEC 62443-3-3 System security requirements & Security Levels		IEC 62443-2-2 System design IACS Protection levels IEC 62443-2-4 Requirments for IACS solution suppliers IEC 62443-3-2 Suppliers Security risk assessment and
System intergration implementation / realisation	Systems builders Asset Owners				
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Security Architecture					
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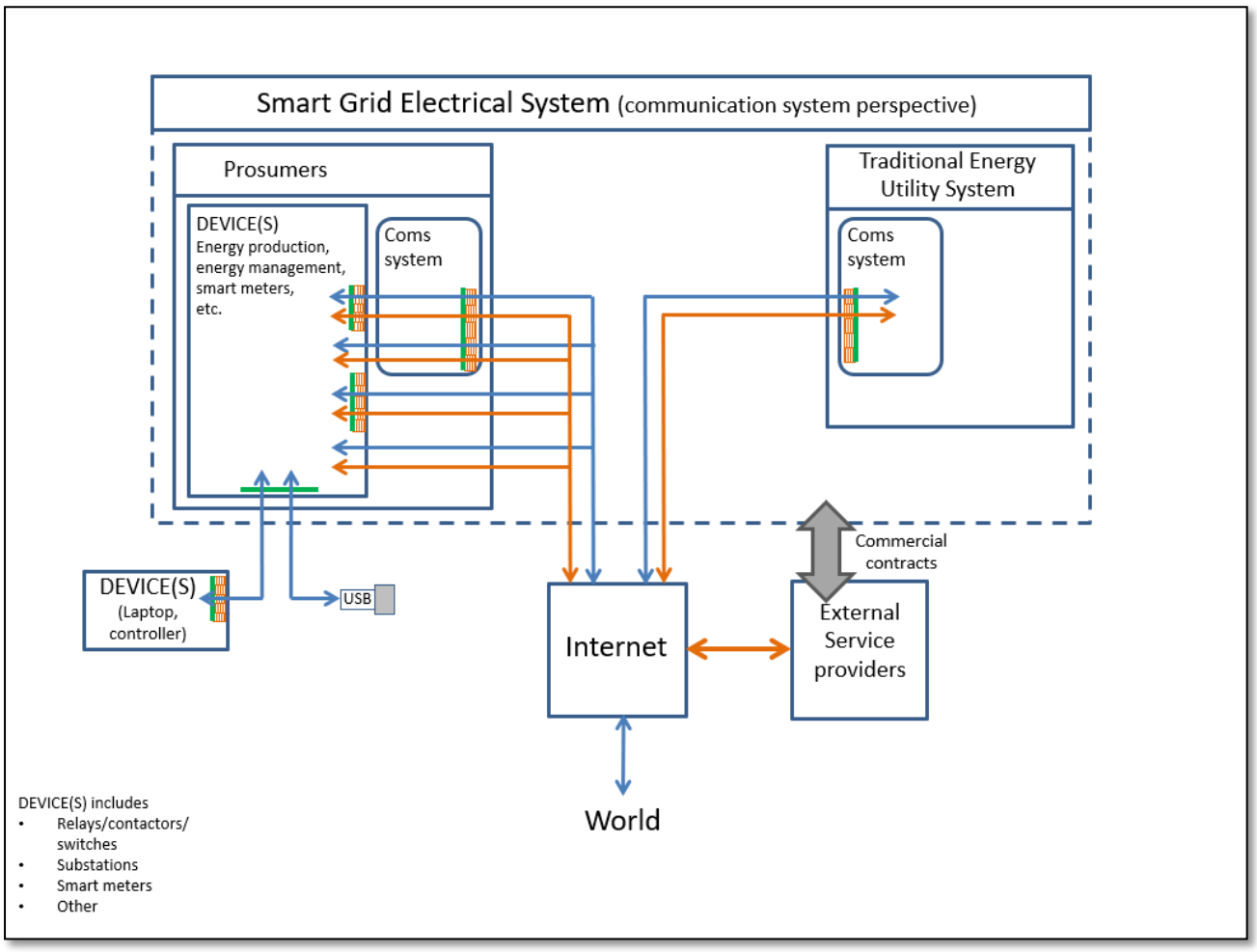
Security solutions	Asset Owner Service provider		IEC 62443-3-1 Security technologies for IACS IEC 62443-3-3 System security requirements & Security Levels	ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-4 Requirements for IACS solution suppliers
1. Patch management implementation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-3 Patch management in the IACS environment

Smart Grid Electrical System

The smart grid electrical system is different from a traditional electrical utility system in that there is no centralized electrical energy generation, and no transmission system. However, there is a distribution system which is a bidirectional system where energy can flow in all directions. There are many energy producers on the system who in most cases are also energy consumers (prosumers). For example, homeowners or companies with PV panels will, at certain times, produce energy and inject it onto the distribution grid, and, at other times, feed energy off the grid. A traditional electrical utility may also be a supplier to the grid. Each prosumer will have a smart meter to measure the flow of energy in either direction and communicate correct billing. This system will not have a single asset owner, but rather each energy producer will be a part owner of the system. The management of energy flow will be distributed and imbedded in devices on the system. External service providers will provide patch management and other services. Much of the communication will occur over telecom and internet systems.



Smart Grid Electrical System GMM in table format. (incomplete)

SYSTEM		General	Objects of conformity		
Activities	Who		Products (components/technolgy)	People	Processes
Components					
Systems components development	Component producers Asset Owners	IEC 62443-0-3 gap assessment IEC 62443-1-1 terminology concepts and models IEC 62443-1-2 master glossary of terms and abbreviations IEC 62443-1-3 systems security compliance metrics IEC 62443-1-4 IACS security and lifecycle user cases ISO/IEC 15408 Common Criteria for information Technology Security Evaluation ISO/IEC 27000 Overview and vocabulary ISO/IEC 27001 Requirements	IEC 62443-4-2 Technical security requirments for IACS components		IEC 62443-4-1 Product Development Requirements
Systems components manufacturing	Component producers Asset Owners		Specific product standards with technical (functional and performance) requirements. (Endpoint device security by design.)		
Interconnections					
System intergration design	Systems designers Asset Owners		IEC 62443-3-3 System security requirements & Security Levels		IEC 62443-2-2 System design IACS Protection levels IEC 62443-2-4 Requirments for IACS solution suppliers IEC 62443-3-2 Suppliers Security risk assessment and
System intergration implementation / realisation	Systems builders Asset Owners				
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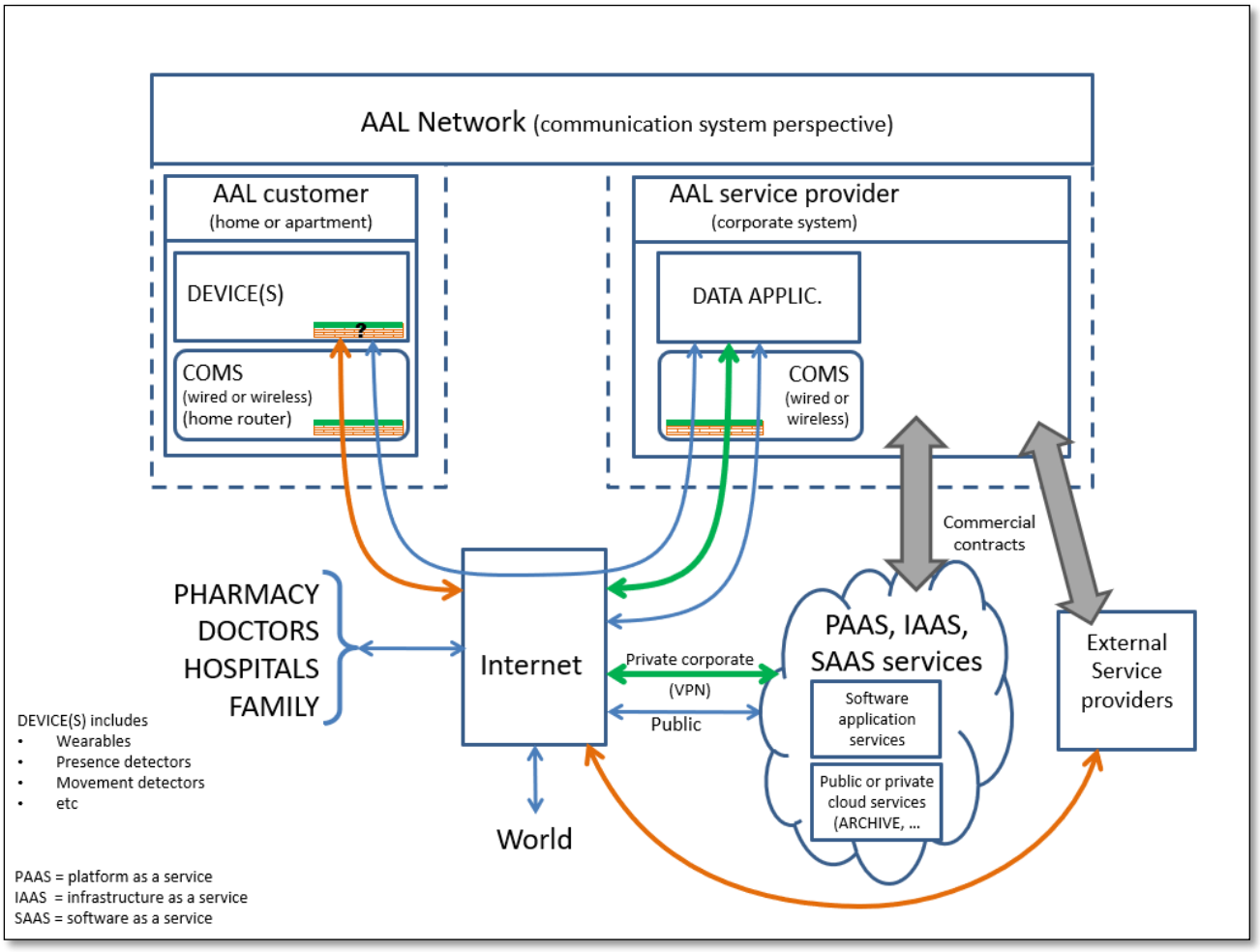
1. Patch management implementation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-3 Patch management in the IACS environment

Active Assisted Living (AAL) System

Future AAL, or active assisted living systems, for the elderly, will use home devices and wearables to monitor and communicate health and activity data to an AAL service provider. The AAL service providers will receive data and transform that into information which will be communicated to health services such as a doctor or hospital, which may then prescribe medications and thus communicate with a pharmacy, and so on. And of course, information may be communicated to family members, and so on. External service providers will also ensure the correct functioning of the remote devices used by the elderly, provide remote updates and patch management, and so on.



Active Assisted Living (AAL) System GMM in table format. (incomplete)

SYSTEM		General	Objects of conformity		
Activities	Who		Products (components/technolgy)	People	Processes
Components					
Systems components development	Component producers Asset Owners	IEC 62443-0-3 gap assessment IEC 62443-1-1 terminology concepts and models IEC 62443-1-2 master glossary of terms and abbreviations IEC 62443-1-3 systems security compliance metrics IEC 62443-1-4 IACS security and lifecycle user cases ISO/IEC 15408 Common Criteria for information Technology Security Evaluation ISO/IEC 27000 Overview and vocabulary ISO/IEC 27001 Requirements	IEC 62443-4-2 Technical security requirments for IACS components		IEC 62443-4-1 Product Development Requirements
Systems components manufacturing	Component producers Asset Owners		Specific product standards with technical (functional and performance) requirements. (Endpoint device security by design.)		
Interconnections					
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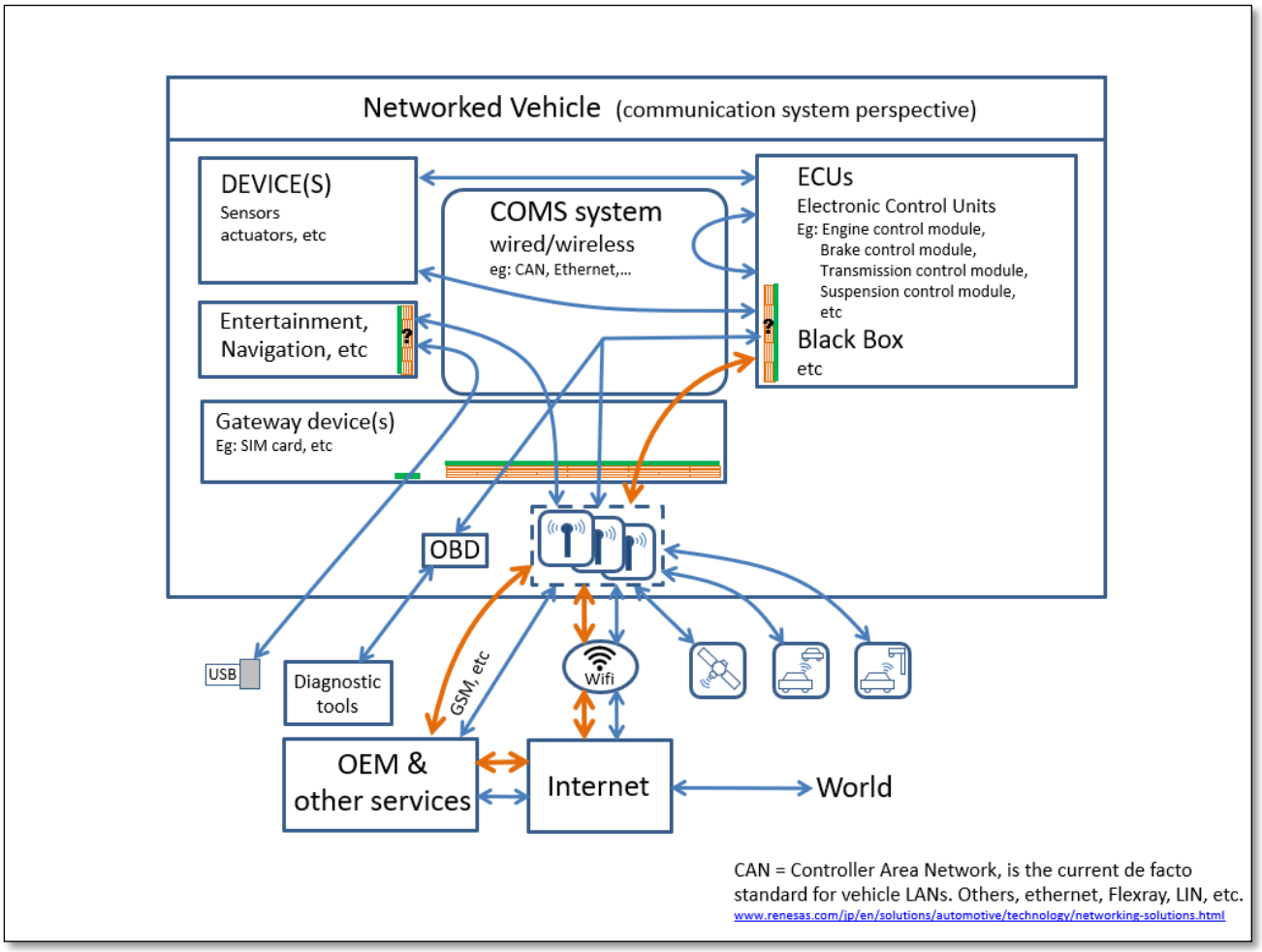
Networked Vehicles System

Networked vehicles is a current and future application. In this case the device, a vehicle, is mobile and can of course be very dangerous for those being transported and/or for those nearby. In this case data is transmitted over various communication channels and can be unidirectional, or bidirectional. The data may simply be entertainment information or could be GPS and other position or traffic information, or could be vehicle performance data, or could be vehicle to vehicle detection and communication, or vehicle to infrastructure communication (toll gates, toll tunnels, toll bridges, etc) or could be vehicle-systems upgrade information, and so on.



Networked Vehicles System GMM in table format. (incomplete)

SYSTEM		General	Objects of conformity		
Activities	Who		Products (components/technolgy)	People	Processes
Components					
Systems components development	Component producers Asset Owners	IEC 62443-0-3 gap assessment IEC 62443-1-1 terminology concepts and models IEC 62443-1-2 master glossary of terms and abbreviations IEC 62443-1-3 systems security compliance metrics IEC 62443-1-4 IACS security and lifecycle user cases ISO/IEC 15408 Common Criteria for information Technology Security Evaluation ISO/IEC 27000 Overview and vocabulary ISO/IEC 27001 Requirements	IEC 62443-4-2 Technical security requirments for IACS components		IEC 62443-4-1 Product Development Requirements
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System intergration implementation / realisation	Systems builders Asset Owners				
Interventions					
Security Management System 1. Requirements	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-1 Establishing an IACS security program
2. Implementation / realisation					IEC 62443-1-4 IACS security and lifecycle use cases IEC 62443-2-2 IACS protection levels
3. IACS Risk Assessment	Asset Owner Service provider		IEC 62443-3-3 System security requirements & Security Levels	ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-2 IACS Protection Levels IEC 62443-3-2 Security risk assessment & system design
Security Architecture					
Security Operation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-2 IACS security and
Security solutions	Asset Owner Service provider		IEC 62443-3-1 Security technologies for IACS IEC 62443-3-3 System security requirements & Security Levels	ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-4 Requirements for IACS solution suppliers
1. Patch management implementation	Asset Owner Service provider			ISO/IEC 27021 IT security management Competence requirements	IEC 62443-2-3 Patch management in the IACS environment