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BAKU 12-14 OCTOBER
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Keynote speech

IP Platforms and Satellite Networks as a booster for Smart City Capabilities

Prof. Michele Luglio
University of Rome
Tor Vergata








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Smart city rationale

- Increase efficiency
- Reduce costs
- Improve quality of life



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Methodology

Use of technologies

- electronics
- computer science
- telecommunications

Is it sufficient

????????????

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DECALOGUE of Smart Cities

1. ICT technology is fundamental but it's not sufficient alone
2. Technology must always facilitate and sometimes replace
3. Identify well the requirements and face the life cycle of the system with rigorous and adequate methodologies
4. Training is irreplaceable
5. Not all our activities need technologies to be smart (some already are smart)
6. Solutions must be standard
7. Attention to personal privacy!!!!!!
8. Data security must be cared from the very beginning
9. From the use of shared equipment to the fruition of a shared service
10. Before developing solutions to solve a problem try to eliminate the problem (mobility can be improved reducing the need to travel)

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Application fields: TOP 16

Environment (pollution and waste) Estate Public administration Sport Energy (consumptions and pollution) Commerce Tourism Hobby and free time Health Jobs Transportation Logistic News Justice Education Safety & Security

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Emergency vs Innovation

Emergency Innovation



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Use of up to date technology



Technology used on field

Latest technology

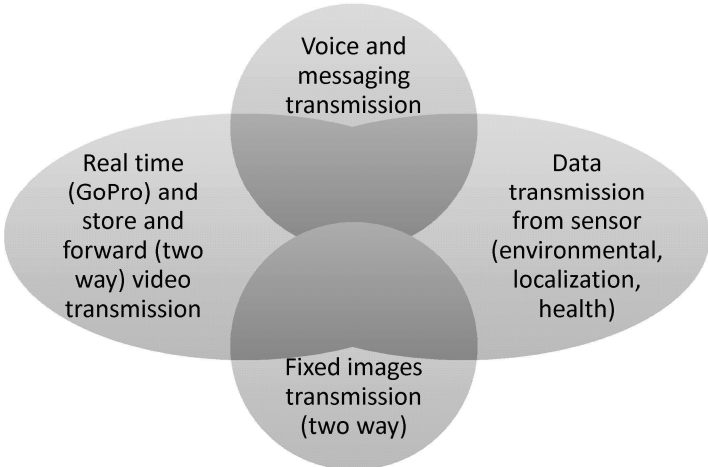
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Services



Voice and messaging transmission

Real time (GoPro) and store and forward (two way) video transmission

Data transmission from sensor (environmental, localization, health)

Fixed images transmission (two way)

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Components of the Smart City

Warning
Telecommunication network usually not adequately cared

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Emergency scenario

- ⇒ Different teams belonging to different corps
 - ⇒ Even in the same country
 - ⇒ Especially for big events
- ⇒ Telecommunication technologies of each team adopt different standard,
 - ⇒ meaningfully decreasing the efficiency of the operations and
 - ⇒ thus the safety of fire fighters themselves other than of the citizens.
- ⇒ **Requirements**
- ⇒ Interconnecting the different systems by means of a common platform which manages the interoperability.
- ⇒ Also the analog systems need to get such an interface
 - ⇒ after analogue/digital conversion of the signal, and be capable to set up a call with digital telephones even for multiple connection sessions

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Smart city solutions implementation

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network plane

Common unique platform to develop and manage all the services and to host applications

Common heterogeneous infrastructure for efficient data circulation

software plane

International Technical Working Group on IoT-Enabled Smart City Framework
<https://pages.nist.gov/smartcitiesarchitecture/>

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Integration of networks

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Physical

Network

Application

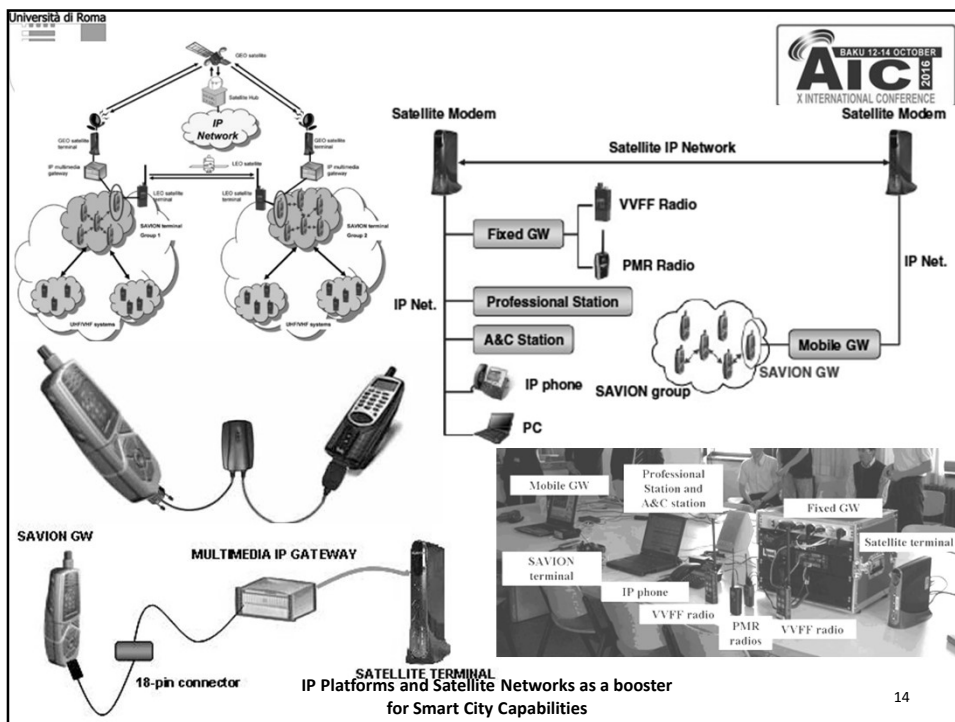
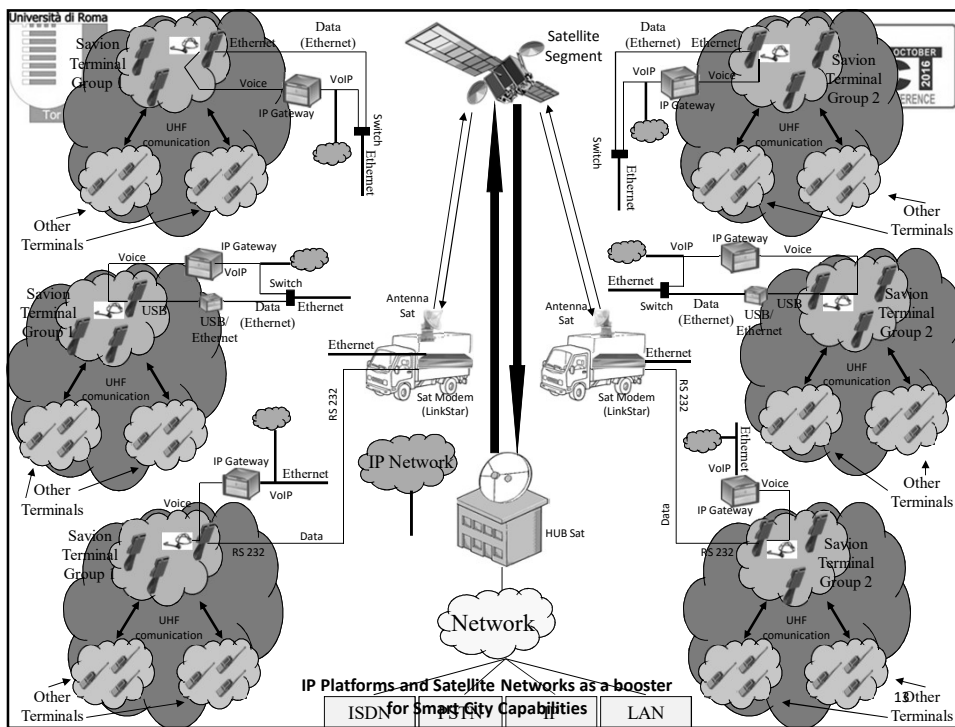
Open Standard

Integration (interoperability) among systems

Convergence (e.g. IP)

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Internet components

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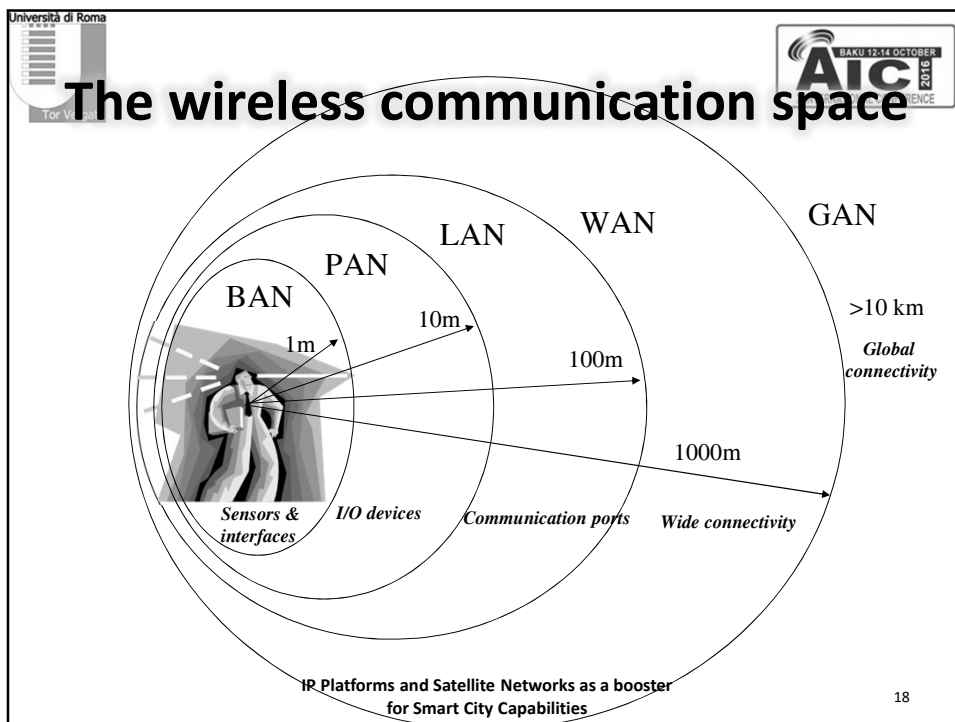
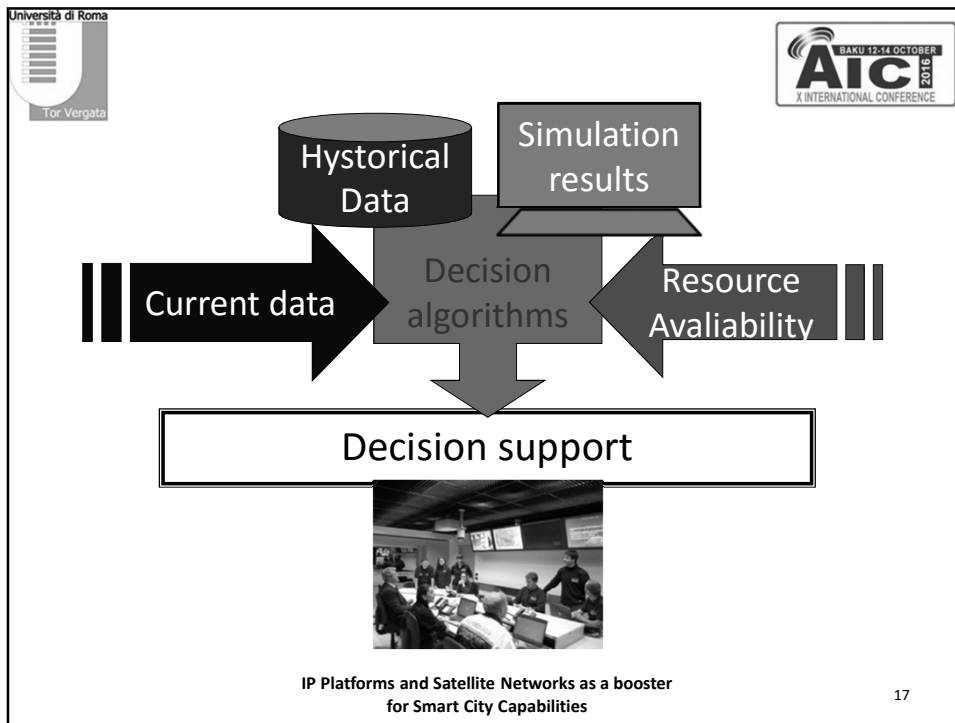
Internet capabilities to satisfy communication needs of smart cities

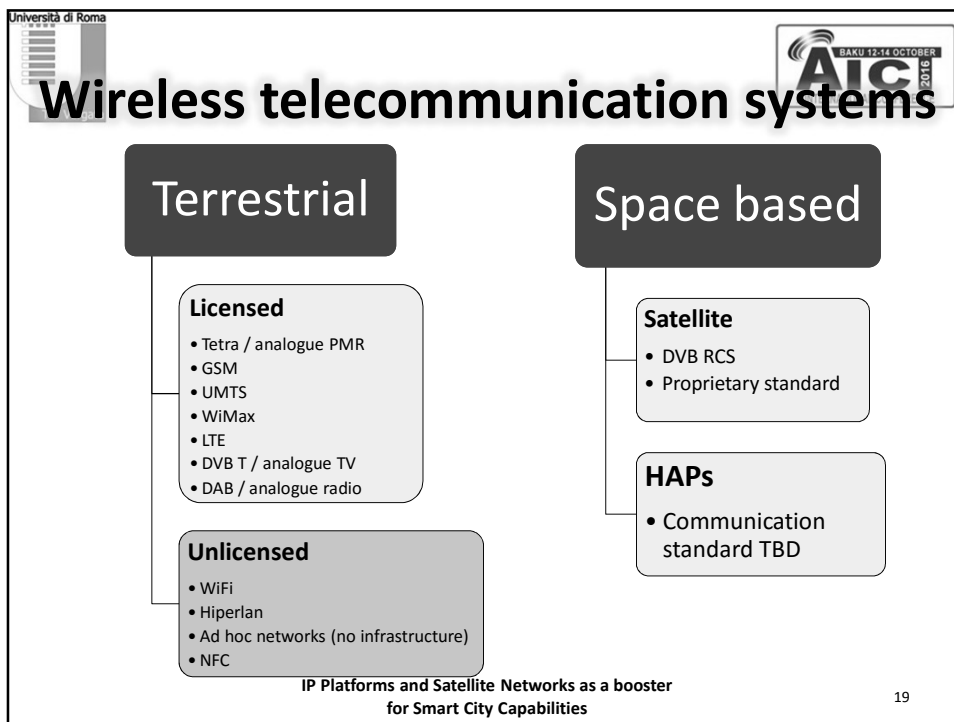
Past	Transition from the guarantee and rigidity offered by the circuit switching to the flexibility and services that the IP networks can offer
Present	Even in the case the same standard is used (for example 3G) applications over IP are used (WhatsApp, Viber, Skype, Maps, etc.) which offer several advantages
Future	Optimum resource management, quality of service and priorities policies for multiple traffic types. Dynamic infrastructure set up, flexible architecture awareness, dynamic QoS. QoS/QoE aware dynamic selection of: <i>segments, protocols and operators.</i> New paradigms: Cloud, ICN, CDN, SDN, NFV. Orchestration of the new paradigms.

transparent to the end-users through service level awareness mechanisms and indicators

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The past, present and future generations of mobile systems

Generation	Technology
1	Analogue
2	Digital, circuit switching, narrow band (GSM)
3	Digital, circuit and IP packet switching, wide band (UMTS)
4	Larger bandwidth and data rate (LTE)
5	Larger bandwidth, SDN, NFV, lower power consumption, billions of connections


Changes
→
KPIs

- 1. compute and storage services provision**
 - distributed computer, with processes and applications dynamically created, moved, deleted
- 2. explosion of IoT and M2M comms**
 - effective authentication, naming, addressing, routing and related functions for a vast number and kind of terminals
- 3. vertical sectors (Automotive, Industry 4.0, Entertainment, Energy and Ehealth)**
 - transport and computing services as virtual distributed computers under complex SLAs

- 1000 times higher mobile data volume per geographical area.
- 10 to 100 times more connected devices.
- 10 to 100 times higher typical user data rate.
- 10 times lower energy consumption.
- End-to-End latency of < 5ms.
- Location precision < 3m
- Mobile speed up to 500 km/h
- Ubiquitous 5G access including low density areas.


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Why to use satellite?




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Costs independent on distance (within one satellite coverage)




Collecting and broadcasting characteristics




Particularly suitable and cost effective for multicasting




Irreplaceable in areas with scarce or no infrastructures




Irreplaceable in case of disaster




Suitable for large coverage areas and long range mobility




Relatively short deployment time



Flexible architecture




Bypass very crowded terrestrial networks



With the same infrastructure both fixed and mobile services


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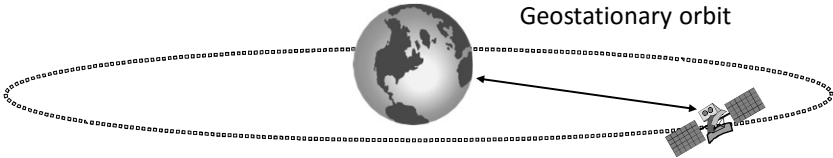
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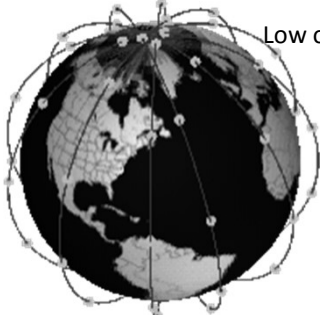
Orbital configurations



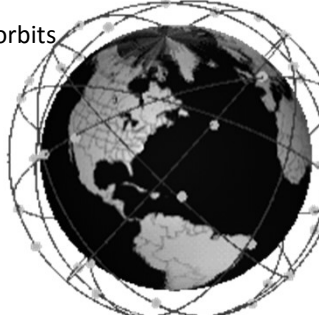
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Geostationary orbit






Low or medium orbits




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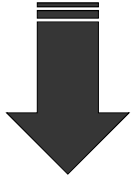


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Satellite and smart city




- The city is the environment in which we live
- The life of the city depends also on surrounding and even on quite far territories (drinkable water, electric power, food, etc.)



- Long distance communications very important


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Satellite and Emergency management



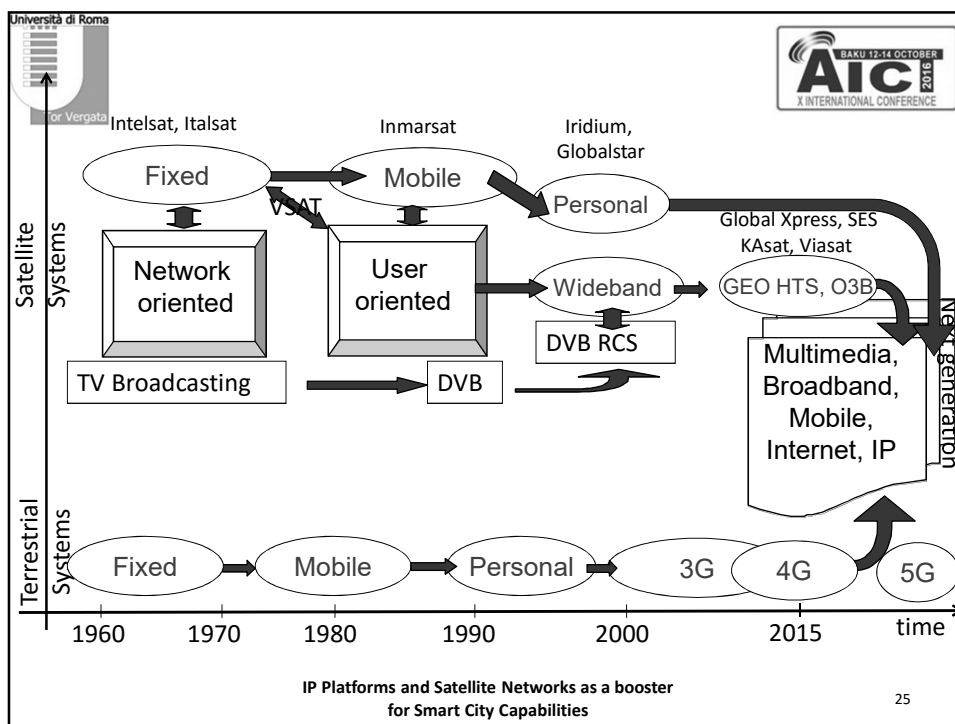
- Intervention often in remote areas not served by terrestrial networks
- In case of big calamity terrestrial networks out of order
- Important the capability to broadcast information
- The satellite systems can interconnect rescue teams among one another and with a remote control center.
- Important the capability to collect data from large areas
- They can offer service both directly and interconnect systems currently utilized by rescue teams.



- Long distance communications very important

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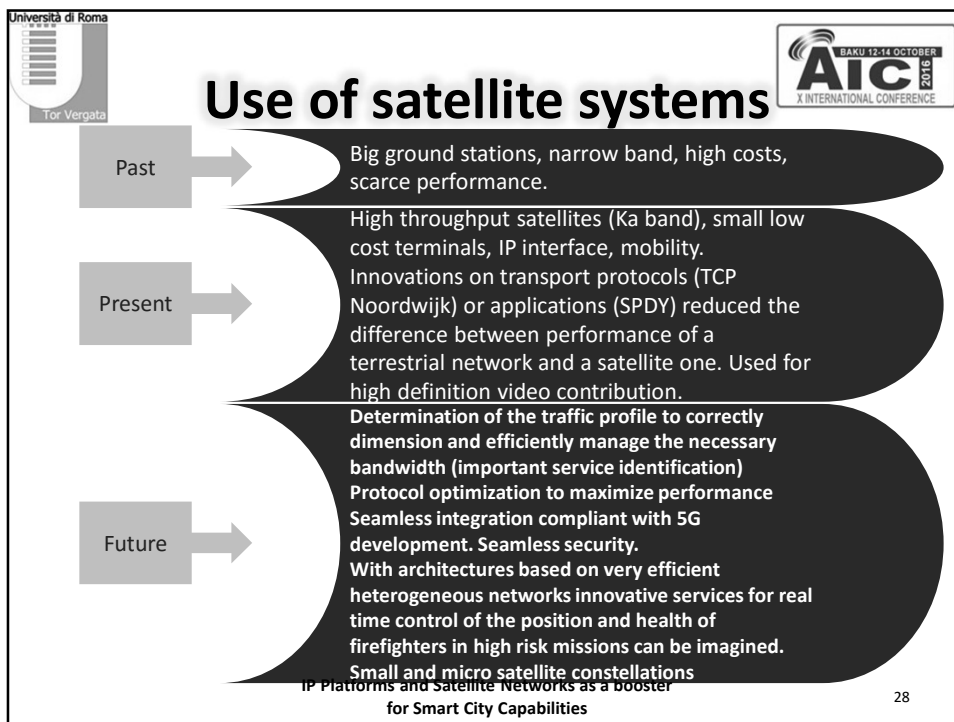
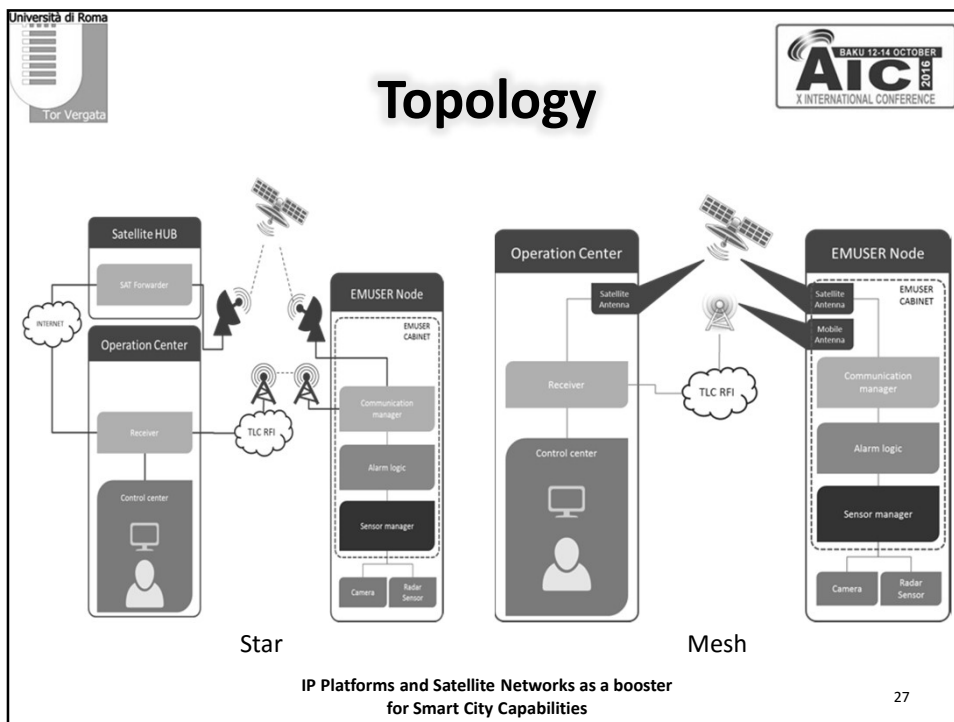


Role of Satellite for the 5G

<ul style="list-style-type: none"> • Drivers for 5G <ul style="list-style-type: none"> – User demand mobile data growth (1 Gbit/s) – Smarter/flexible networks – virtualisation, SDN, Dense networks with smaller cells, area spectral efficiency needs to be increased by an order of magnitude – Spectrum sharing – mix of licenced and unlicenced – Lower energy by 90% – Internet of Things, billions of objects connected (big data) – More resilient & secure systems at no extra cost improving QoE. 	<ul style="list-style-type: none"> • Satellite role in 5G <ul style="list-style-type: none"> – Coverage air, sea and remote areas-extending terrestrial mobile networks. – Services broadcast and multicast. Cloud services and bulk downloads. – Integrated approach taking the load off the terrestrial network (particularly video); ICN/CDN—optimum deliver services with novel combinations—integrated standards – Backhaul – providing flexibility of higher rate backhaul and the control overlay cell in a heterogeneous network. Integration with 5G core network – Flexibility – High uplink data rate on demand or when needed
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Emergency and security

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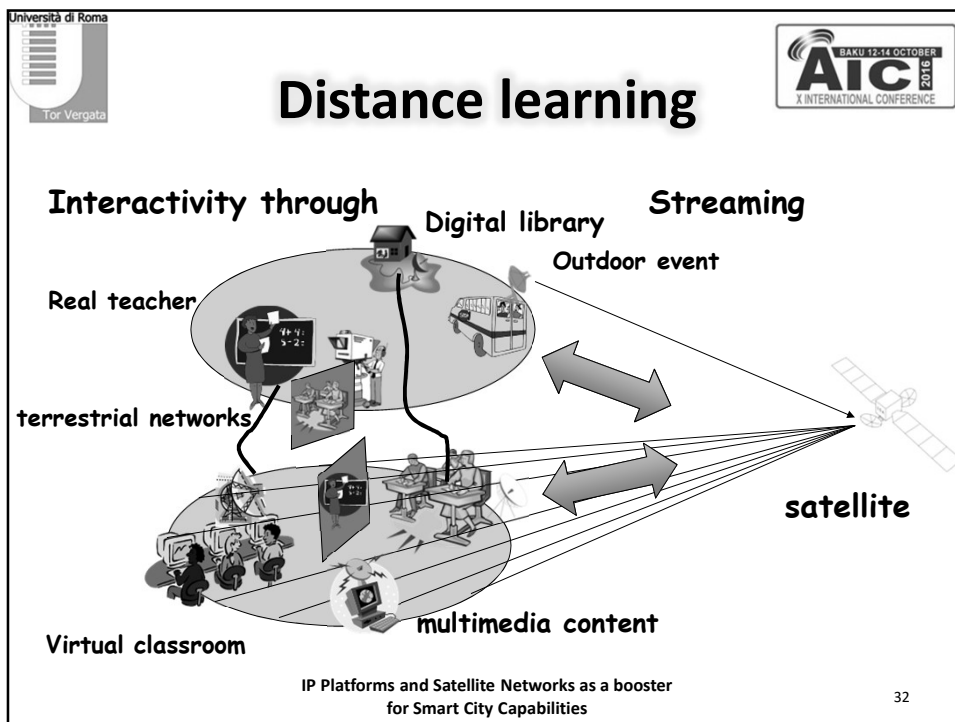
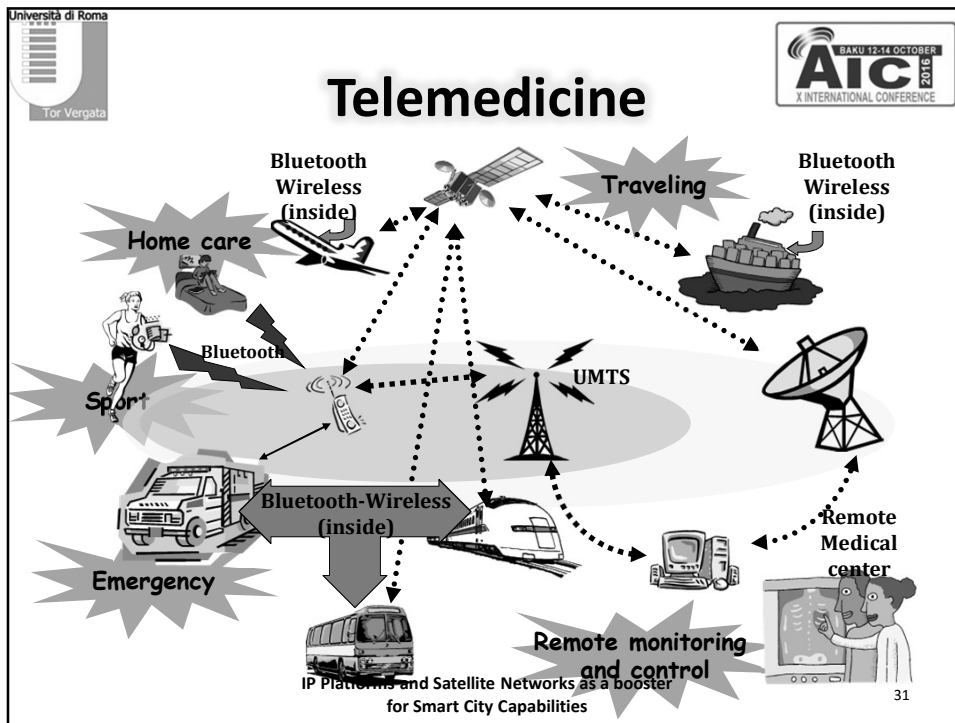
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Sensor networks for environmental and critical infrastructures monitoring

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Air traffic control

Broadcast Satellites

Two-way Comm Satellites

ATM Space System

Navigation Satellites (GPS, Galileo, GLONASS)

Network Center

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ATM-213
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Cultural heritage

WLAN

BLUETOOTH

OBSERVATION

UMTS

GPRS

MUSEUM

HISTORICAL SITE

WLAN

ARCHEOLOGICAL EXCAVATION

Virtual Reality Lab

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Transportations

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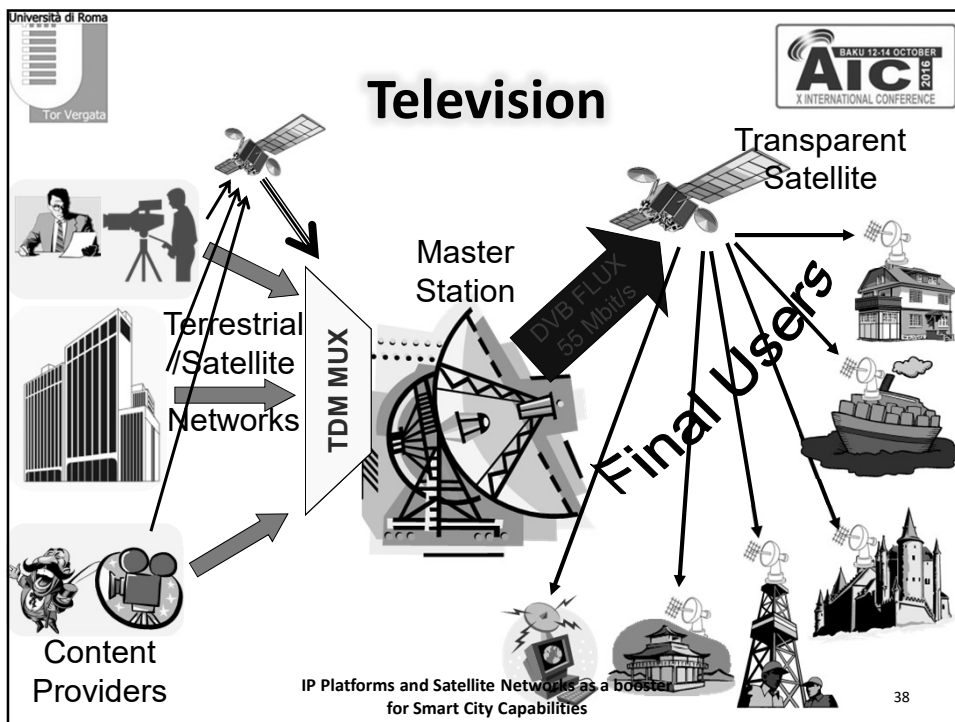
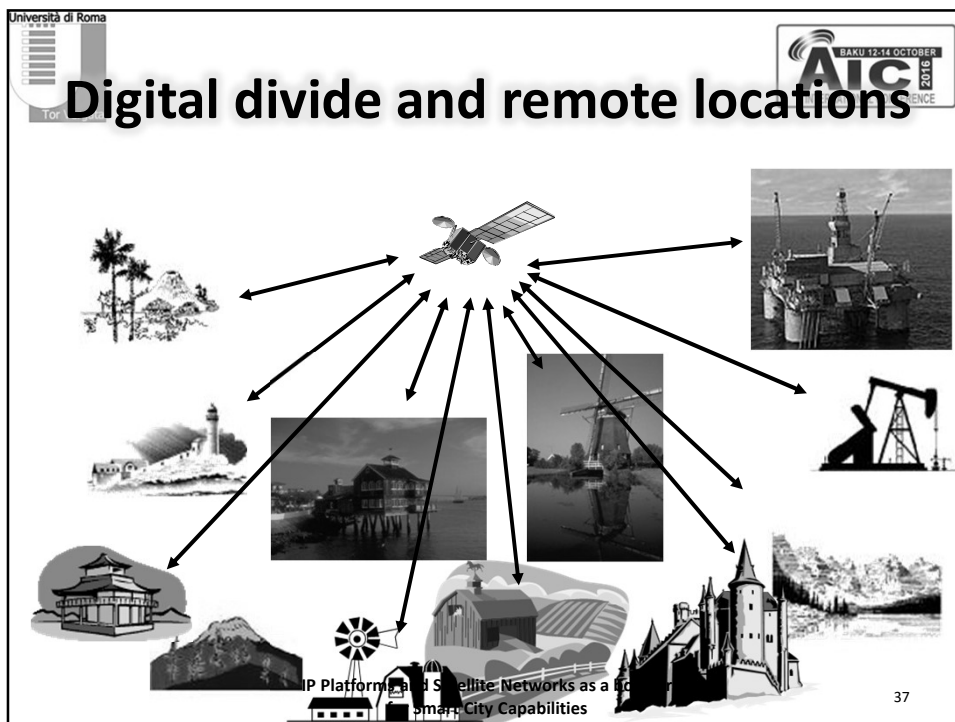
Security & Safety services

Security ← Decision support → Safety

- Remote door opening control
- Cryptographic key distribution
- Confidentiality, authentication integrity ensured
- IPSec and other standard compliancy

- Dangerous goods transportation
- Data collection from public transportation means
- Support to infomobility
- Critical infrastructures and territory surveillance and monitoring

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LAN or ad hoc networks on Internet

Subnet #1
Subnet #2
Subnet #N

Broadcast channels
MF-TDMA

User terminals
Access Router
Satellite Terminal #1
Satellite Terminal #2
Terminal #N

Network Control Centre
Satellite Gateway
DVB-RCS

IP Network
Satellite Hub
IP multimedia gateway
Remote Station
SAVON team #1
SAVON team #2

Internet
Remote Servers

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Energy and smart grid

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Many actors, one system

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Overview on commercial satellite systems

	Service	Low data rate	High data rate Multimedia
Orbit			
LEO		OrbComm Globalstar Iridium	
MEO			O3B
GEO		Inmarsat Thuraya	Intelsat, SES-Global, Eutelsat, Hispasat, Hellasat, Spaceway, Avanti, Inmarsat, Viasat


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Commercial models



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Systems for low data rate services

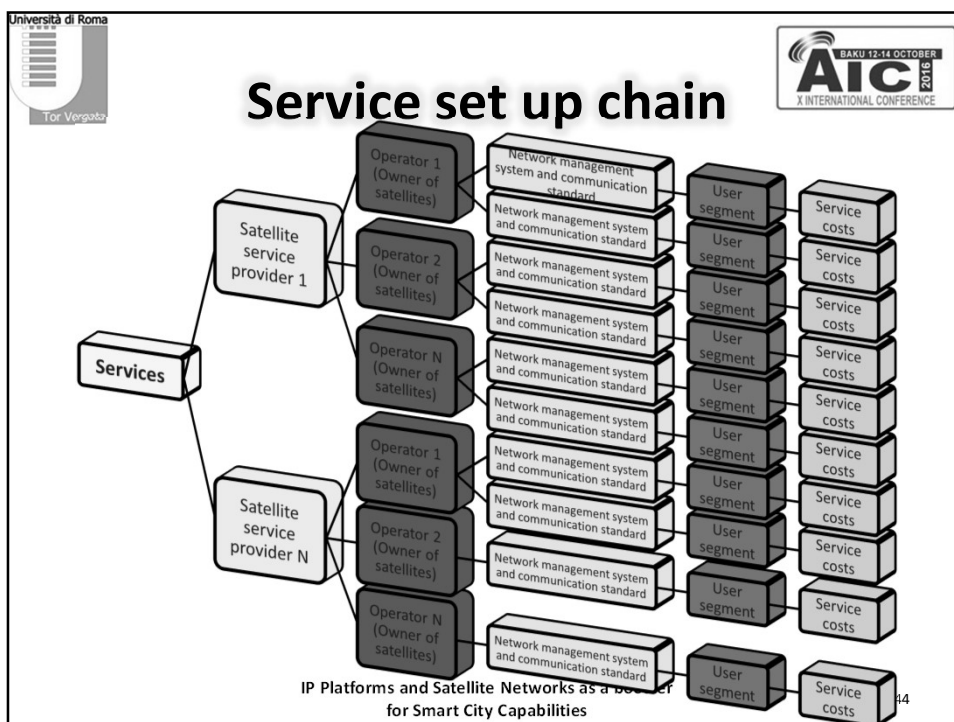
- System and service: 1:2:1 relationship
- Only two freedom degrees
 - the operator
 - fare plan

Systems for high data rate and multimedia services

- Service \neq System
- Freedom degrees:
 - Operator
 - Satellite } Space segment
 - Service
 - User segment (modem + RF front end and antenna)
 - Costs

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Satellite system coverage

- The issue of the coverage of the satellite systems must be approached carefully. Almost all the commercial satellite service providers claim to offer a **global** or continental coverage but anyway **with no discontinuity**.
- To determine the real coverage the following constraints must be taken into account:
 - The satellite propagation channel allows to establish the link only if the Line Of Sight between the ground terminal and the payload is guaranteed
 - From the geostationary orbit latitudes over $\pm 70^\circ$ are not visible,
 - To close the link the simultaneous visibility of the user terminal and of the gateway with the satellite must occur,
 - The LEO constellations cover a percentage of the Earth surface depending on the number of satellites, of the inclination of the orbits, and may be subject to the previous issue, for example over the oceans.

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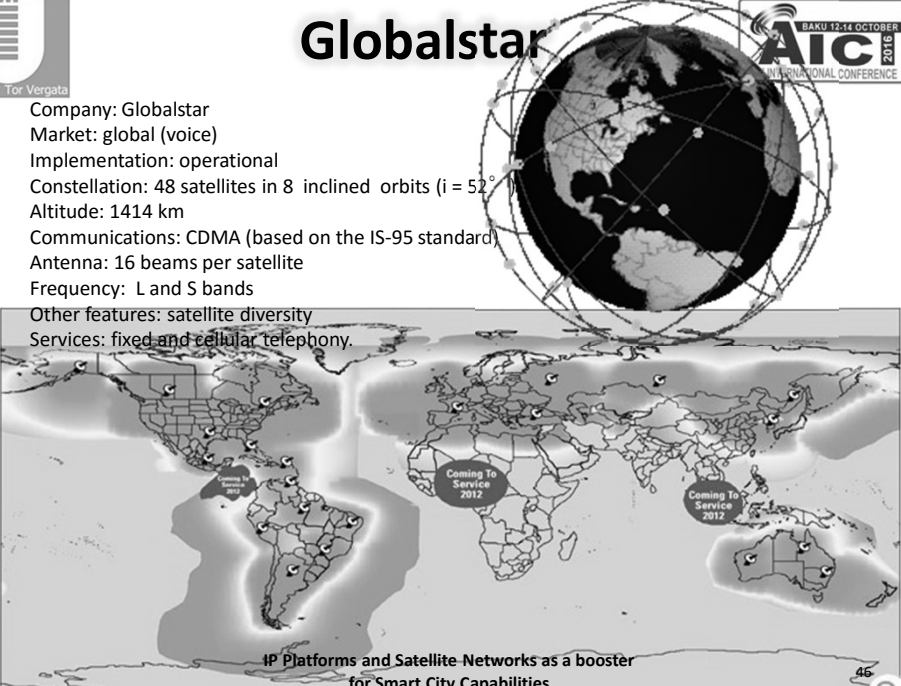
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Globalstar

- Company: Globalstar
- Market: global (voice)
- Implementation: operational
- Constellation: 48 satellites in 8 inclined orbits ($i = 52^\circ$)
- Altitude: 1414 km
- Communications: CDMA (based on the IS-95 standard)
- Antenna: 16 beams per satellite
- Frequency: L and S bands
- Other features: satellite diversity
- Services: fixed and cellular telephony.




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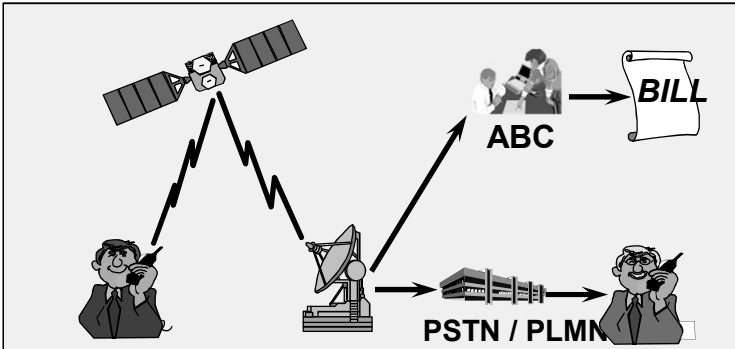


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Architecture: satellite, gateway, terminal



Cellular
Technology


+

Satellite
Technology

+


Existing
Telephone
Infrastructure

=





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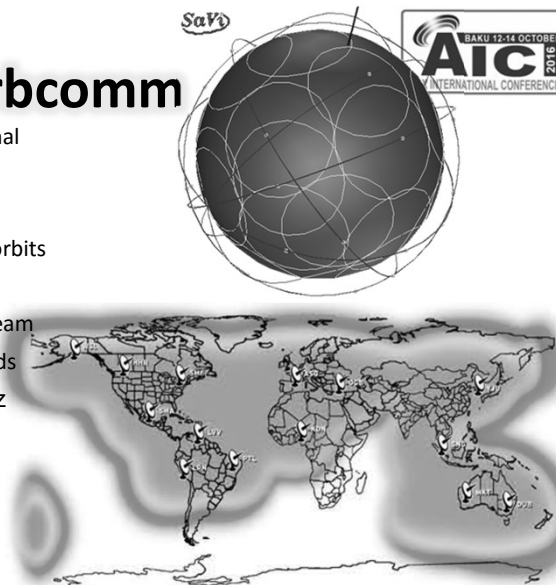
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Orbcomm

- Company: Orbcomm International
- Market: global (M2M)
- Implementation: operational
- Constellation: 31 satellites in 7 orbits
- Altitude: 825 km
- Antenna: linear (whip), single beam
- Communications: VHF/UHF bands



Uplink frequency: 148-150 MHz
Downlink frequency: 137-138 MHz and 400 MHz

Satellite Specifications
 Mass: 172 kg (380 lb)
 Power: 400 Watts
 Stowed Volume: 1m x 1m x .5m (39" x 39" x 20")
 Deployed Volume: 13m x 1m x .5m (512" x 39" x 20")

Primary Service Area (100 - 98% completion rate*)

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for Smart City Capabilities (10% completion rate*)


ASG - Ausageil	OGB - Ogbay
DUB - Dubbo	FTL - Petrolina
HRS - High River	SMA - San Martin
KDN - Kaduna	SMF - Smith Falls
LRN - Lurin	SNG - Singapore
LIV - Los Vilosquez	WSL - Wasilla
MKT - Meekathara	YJU - Yeo Ju

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Sesat coverage



SESAT at 36° East
(predicted nominal fixed beam coverage)

17 dBW, 18 dBW, 19 dBW, 20 dBW

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Ka sat 9° est coverage



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