System Architectures for EGNOS and A-GPS

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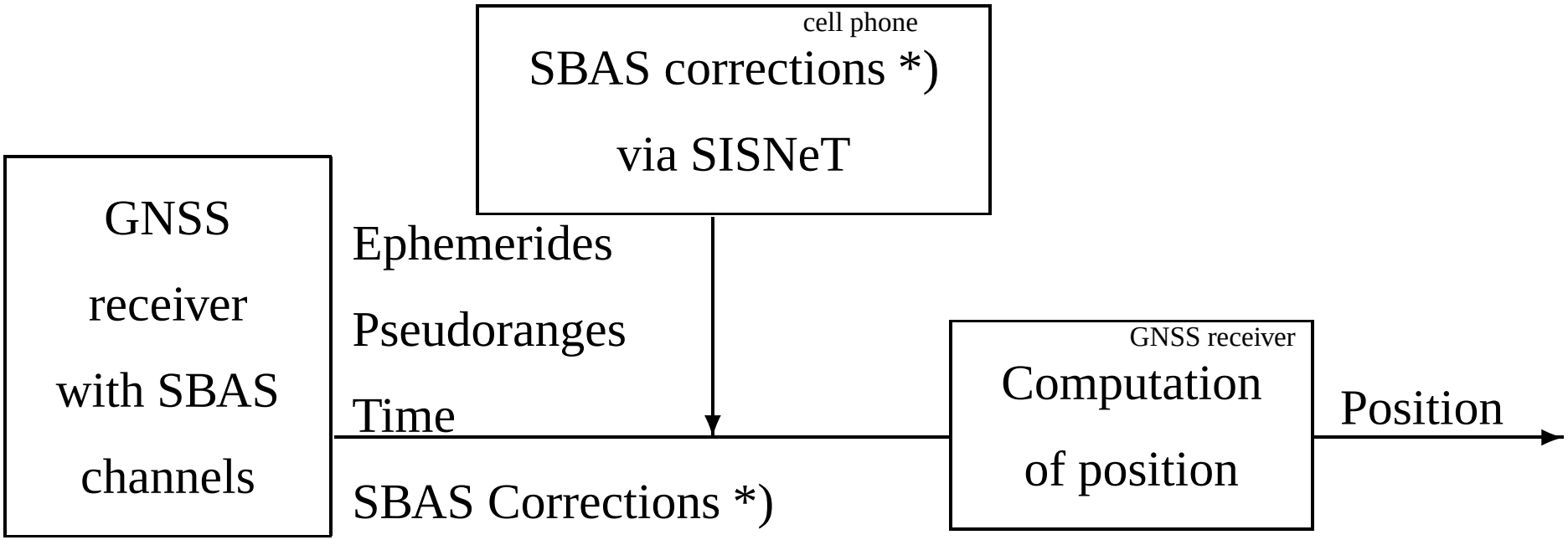
Application: Stand-alone Positioning, $\sigma < 1\,\mathrm{m}$

We want to improve the stand-alone receiver's accuracy by using a satellite-based augmentation system (SBAS).

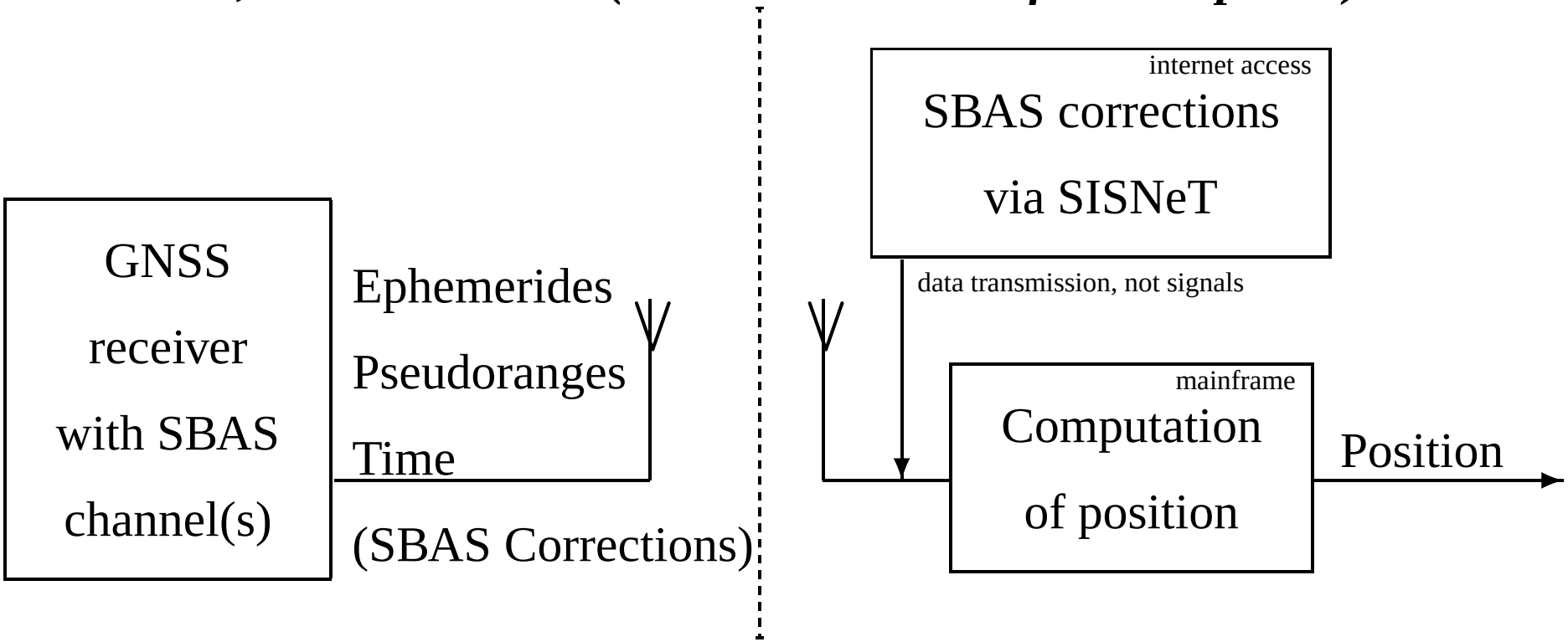
Scenario I, rover alone (GNSS receiver and cell phone)



*) The SBAS corrections can be obtained either from a geostationary satellite, which transmits GPS-like signals, or via a data transmission from the internet.

Application: Location Based Billing

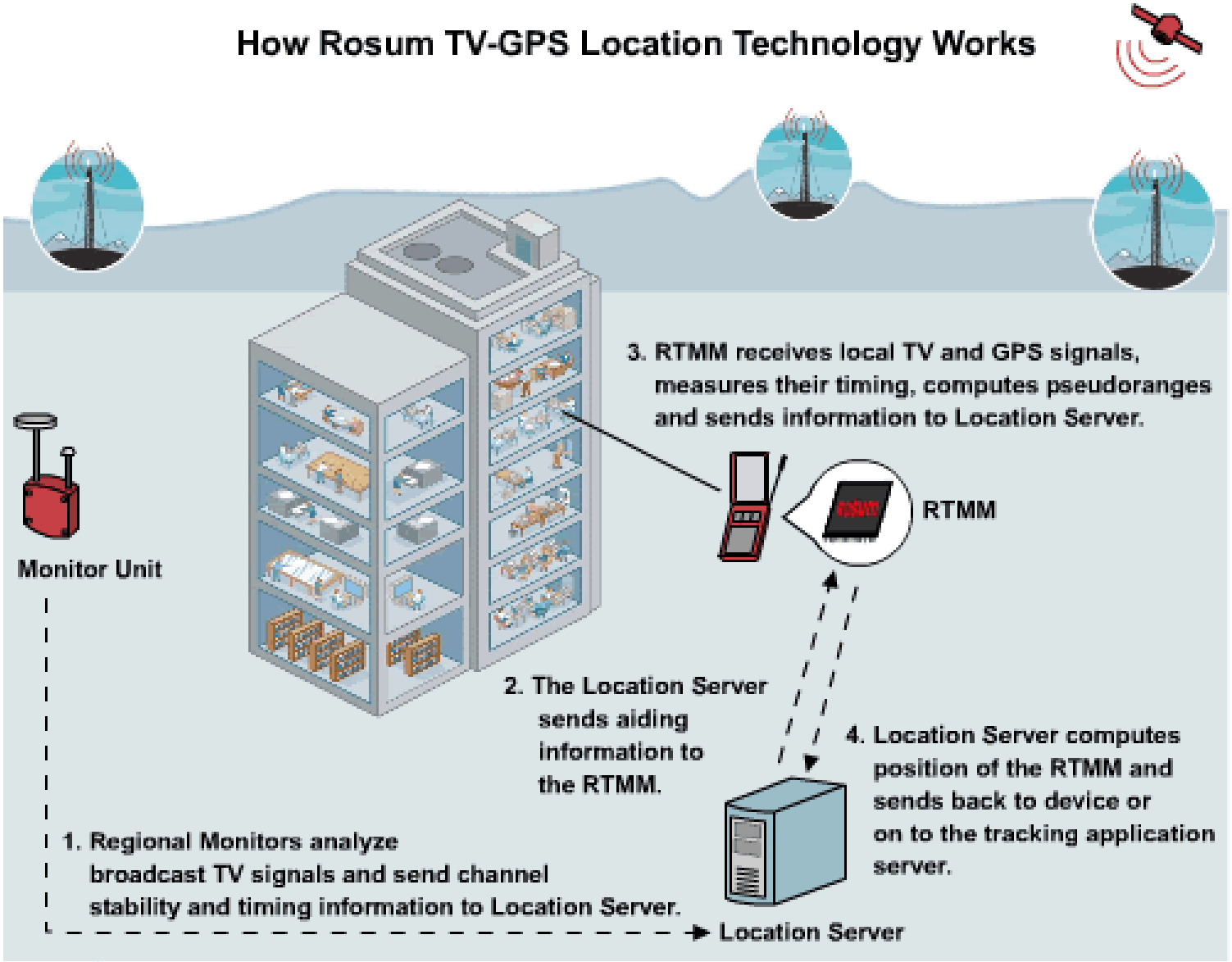
Scenario II, rover and server (GNSS receiver and fixed net phone)



The transmitter and the receiver connected to the antennas are omitted

TV-GPS

TV signals are designed for indoor reception. Rosum TV-GPS uses commercial broadcast TV signals to provide reliable positioning indoors and in urban environments. By combining TV signals with GPS signals, Rosum can provide seamless indoor/outdoor coverage across all environments.


How Rosum TV-GPS Location Technology Works
3. RTMM receives local TV and GPS signals, measures their timing, computes pseudoranges and sends information to Location Server.
RTMM
Monitor Unit
2. The Location Server sends aiding information to the RTMM.
4. Location Server computes position of the RTMM and sends back to device or on to the tracking application server.
1. Regional Monitors analyze broadcast TV signals and send channel stability and timing information to Location Server.
Location Server

Rosum TV-GPS

EFFECT	TV-GPS	A-GPS	GPS
Stronger signals are more widely detectable. The greater the *signal level*, the faster the position fix	Typically 1000 KW or more, broadcast within 80 km of commercial and population centers	500 W, from 20 000 km above the Earth's surface	500 W, from 20 000 km above the Earth's surface
Lower *frequencies* penetrate buildings more easily	300–750 MHz. Good indoor coverage	1,512 MHz. Poor indoor coverage	1,512 MHz. Very poor indoor coverage
Wider signal *bandwidth* means more accurate positions	6 MHz	1 MHz	1 MHz
Ensures coverage in difficult environments. *Clear channels* speed signal acquisition by increasing Signal-to-Noise ratios	Every building has slightly different signal attenuation across the broadcast TV spectrum.	All channels use the same frequency. One channel's signal is another channel's noise	All channels use the same frequency. One channel's signal is another channel's noise

Since each TV tower typically broadcasts more than one channel, the Rosum receiver will have a better chance of acquiring a signal given that these channels are broadcast at different frequencies. Rosum can choose the best channels from each tower to compute the user's location

Cell Sites

A cell site is equipped with antennas and electronic communications equipment. The spacing between cell sites is 2–3 km in suburban areas, and 500–1000 meters in dense urban areas. In rural areas typically 20–30 km.

Any cell phone may position itself relatively to the call sites by estimating the distances to the individual call sites. The estimation is most often based on *signal strength*. The typical accuracies achievable are 300 meters in urban areas and 1–2 km in rural areas. This accuracy is not sufficient for E-911 calls.

Assisted GPS (A-GPS)

A-GPS is a concept created in the cell phone realm. Small power consumption is an important parameter in that world. If we add a GPS receiver to a cell phone we immediately improve position-related issues:

- From ephemerides data we may estimate the Doppler shifts
- This prior knowledge of Doppler shift can narrow the search space and thus save time for signal acquisition
- After acquisition it takes 30 s to download an ephemeris; we aim at a as short time to first fix (TTFF) as possible.

A-GPS Cons

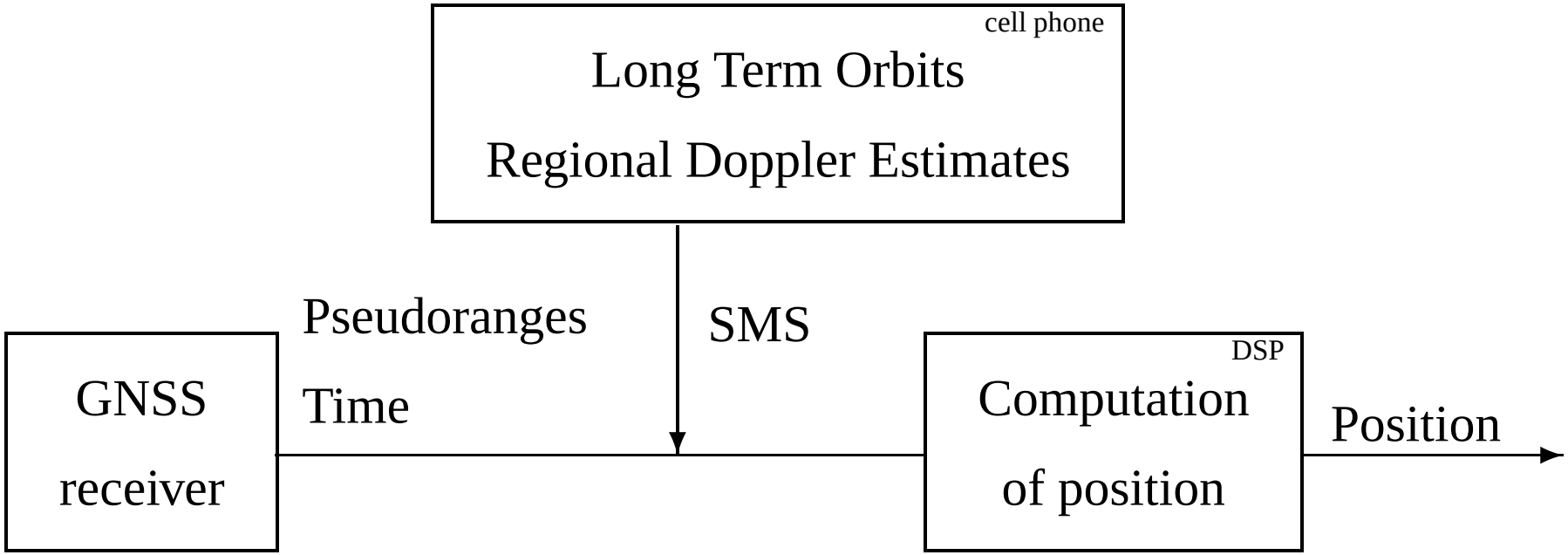
- A-GPS only works in case there is base station (provider) support
- A need for a dedicated GPS monitor network

A-GPS Pros

- TTFF is improved
- Accuracy improvements from differential corrections or SBAS data
- Small aid to weak signal tracking

Application: Positioning of Cell Phone

Scenario III, Assisted GPS



A-GPS Issues

- Each SMS contains 3 ephemerides, see ICD-GPS-200C
- Acquisition $< 1\,\mathrm{s}$
- Long Term Orbits (LTO) are derived from observations made in a world wide reference network of GPS stations with sufficient coverage to track all GPS satellites at all times
- The assistance server can consist of the following types of data, which can also be derived at the user site
  - Orbit and clock information
  - Initial position (Doppler shift may be derived from that) and time estimate

Example I

Benefon Track Positioning and communication with a user interface for professionals who work alone and individuals desiring personal security through location knowledge, emergency button: E-911

Example II

GPS receiver and topographic map

Example III

Fleet management

Examples I and II is sort of fleet management of rescue personal. During 11. September 2002 the rescue leaderships did not know where the personal were at given time.