Myndigheten för samhällsskydd och beredskap

-Consequences of GNSS failure within vital societal functions

-Space weather and its impact on GNSS

2017-10-18
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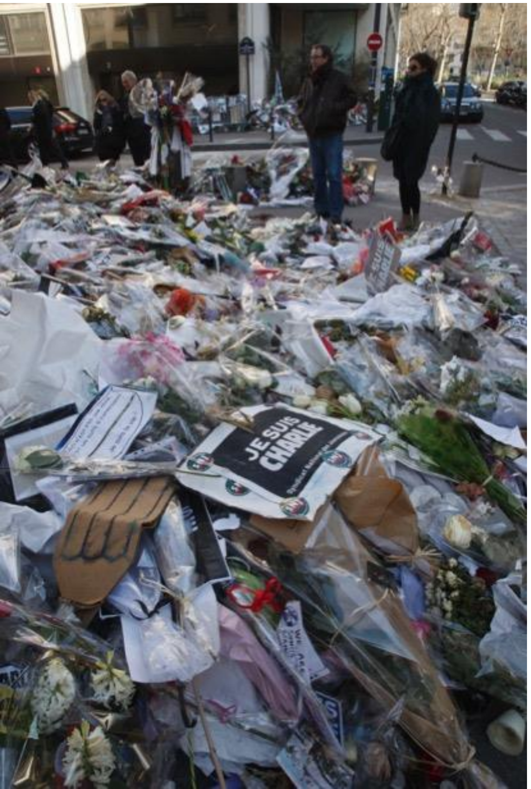
Myndigheten för samhällsskydd och beredskap

Why we are needed



MSB:s mission

MSB contributes to society's ability to …

… prevent incidents

Such that actors can increase their abilities to:

- conduct fire and accident prevention
- have continuity in essential services
- manage hazardous substances
- manage information securely

… manage incidents

Such that actors can increase their abilities to:

- carry out rescue efforts
- coordinate activities during incidents
- support the Armed Forces

Scenario

The following scenario was used in the 2013 National Risk and Capability Assessment

Scenario

Its an ordinary work day at 16:30 the 18th of October. People are on their way home from work and schools.

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Scenario

Suddenly, without warning, Sweden no longer has access to GNSS enabled services.

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Scenario analysis

Transport	Energy	Finance	Trade/industry
Healthcare	Communication	Security	Food

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Scenario analysis

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Transports

- **Air traffic uses conventional navigation techniques**
  - **Will not be affected**
  - **Possible to direct by radar**
- **Road and rail maintenance and construction work will suffer**
- **Commercial sea traffic will suffer**
- **Deliveries will be delayed**

Scenario analysis

Transport	Energy	Finance	Trade/industry
Healthcare	Communication	Security	Food

Energy

- Power grid
  - Alternative solutions available
    - Atomic/internal clocks
- Fuel supply (deliveries)
- District heating (”fjärrvärme”)

→ GNSS loss leads to increased administrative work, but no power outages are expected

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Scenario analysis

Transport	Energy	Finance	Trade/industry
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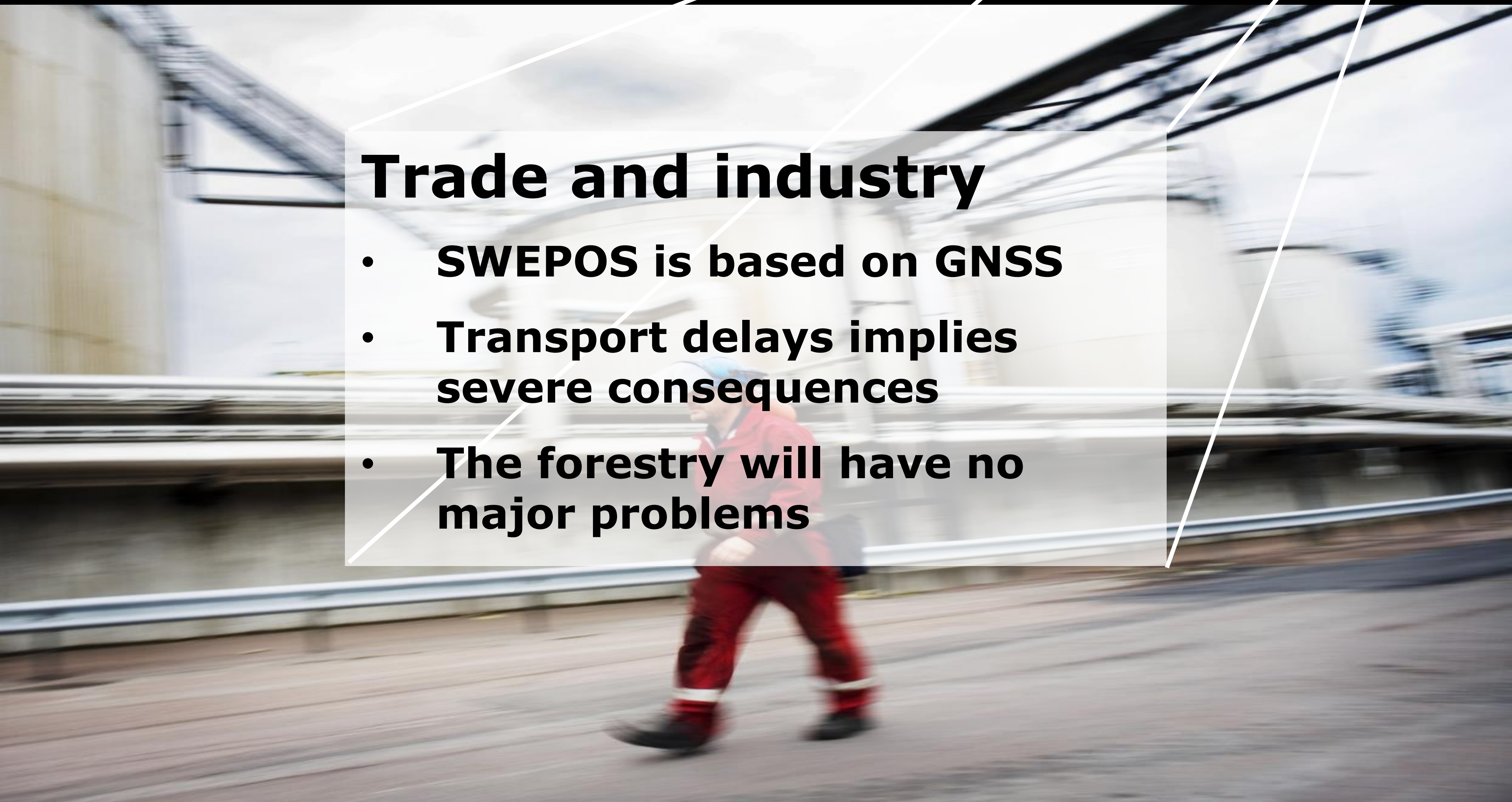
Financial services

- **Agencies within the financial sector will have no major problems**
- **Ticketing systems for municipal transportation might experience problems**

Scenario analysis

Transport	Energy	Finance	Trade/industry
Healthcare	Communication	Security	Food



Trade and industry

- **SWEPOS is based on GNSS**
- **Transport delays implies severe consequences**
- **The forestry will have no major problems**

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Scenario analysis

Transport	Energy	Finance	Trade/industry
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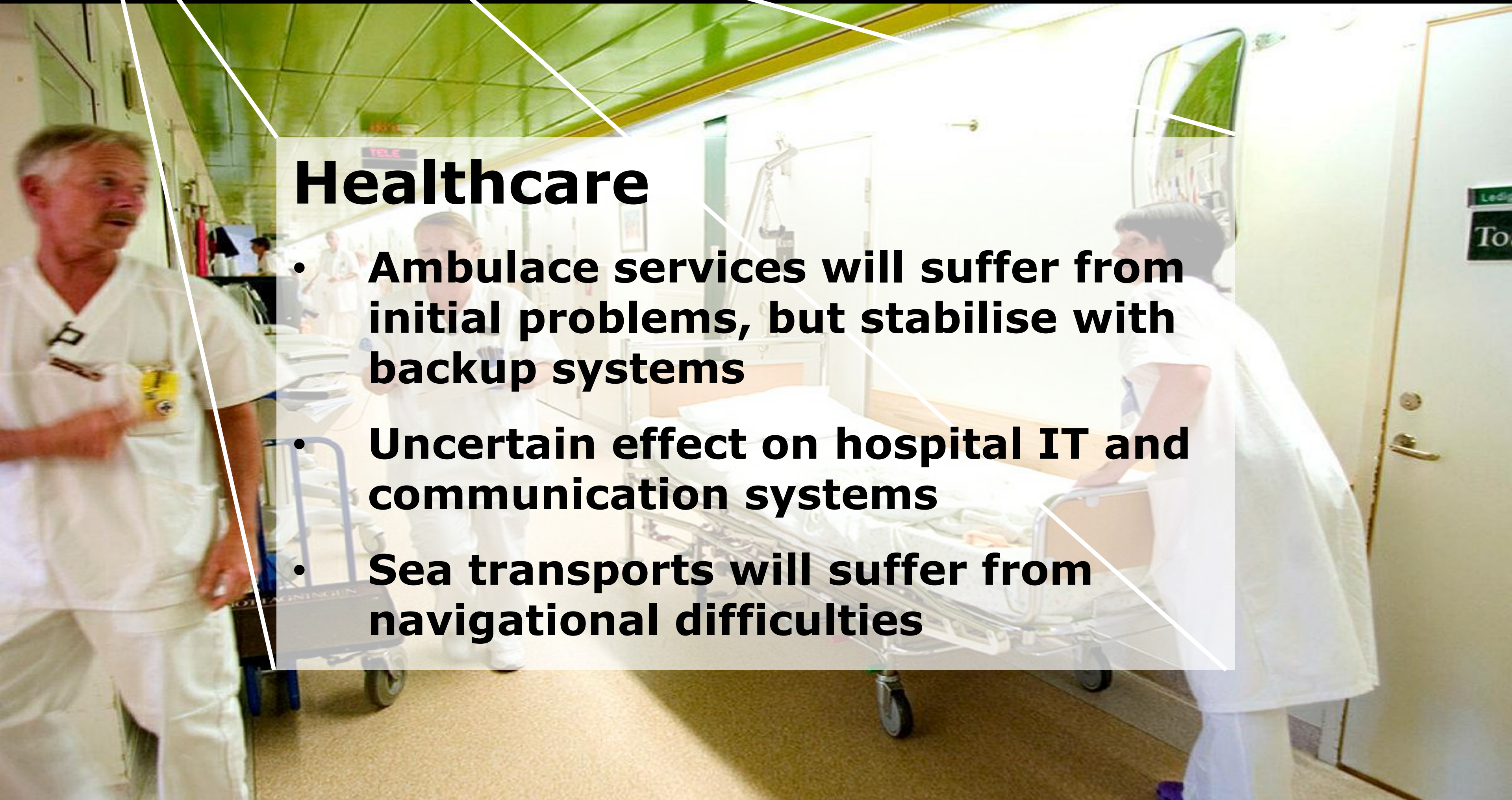

Healthcare

- **Ambulace services will suffer from initial problems, but stabilise with backup systems**
- **Uncertain effect on hospital IT and communication systems**
- **Sea transports will suffer from navigational difficulties**

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Scenario analysis

Transport	Energy	Finance	Trade/industry
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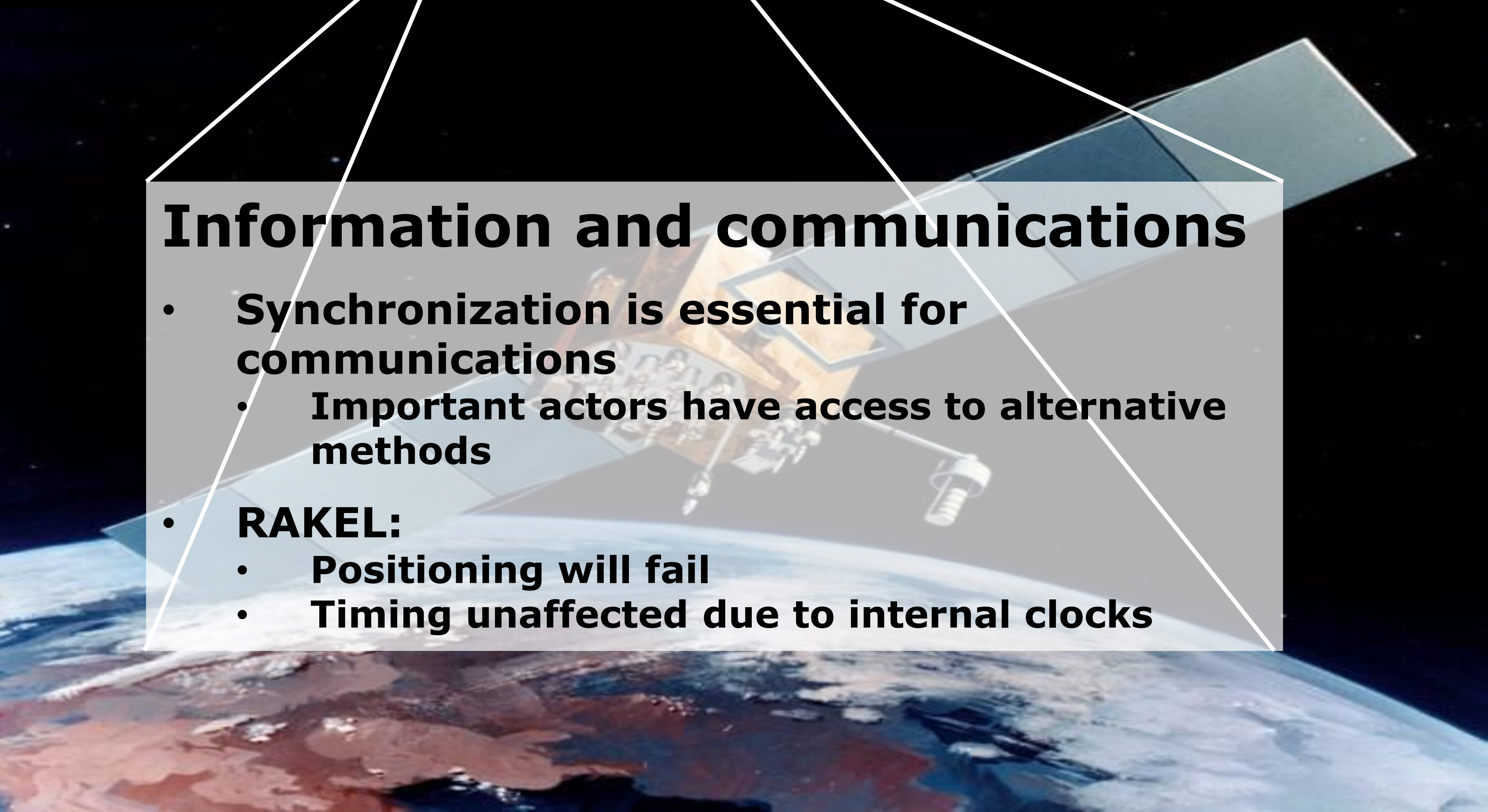

Information and communications

- **Synchronization is essential for communications**
  - **Important actors have access to alternative methods**
- **RAKEL:**
  - **Positioning will fail**
  - **Timing unaffected due to internal clocks**

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Scenario analysis

Transport	Energy	Finance	Trade/industry
Healthcare	Communication	Security	Food

Protection and security

- **Police and rescue services use GNSS two-fold**
  - **For command to locate vehicles**
  - **For units to navigate**
- **Personal safety alarms will fail**
- **Position tagging of criminals will suffer**
- **Rescue services at sea will suffer from loss of positioning**

Scenario analysis

Transport	Energy	Finance	Trade/industry
Healthcare	Communication	Security	Food

Food

- Suffers mainly from delays in deliveries

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Scenario analysis

Transport	Energy	Finance	Trade/industry
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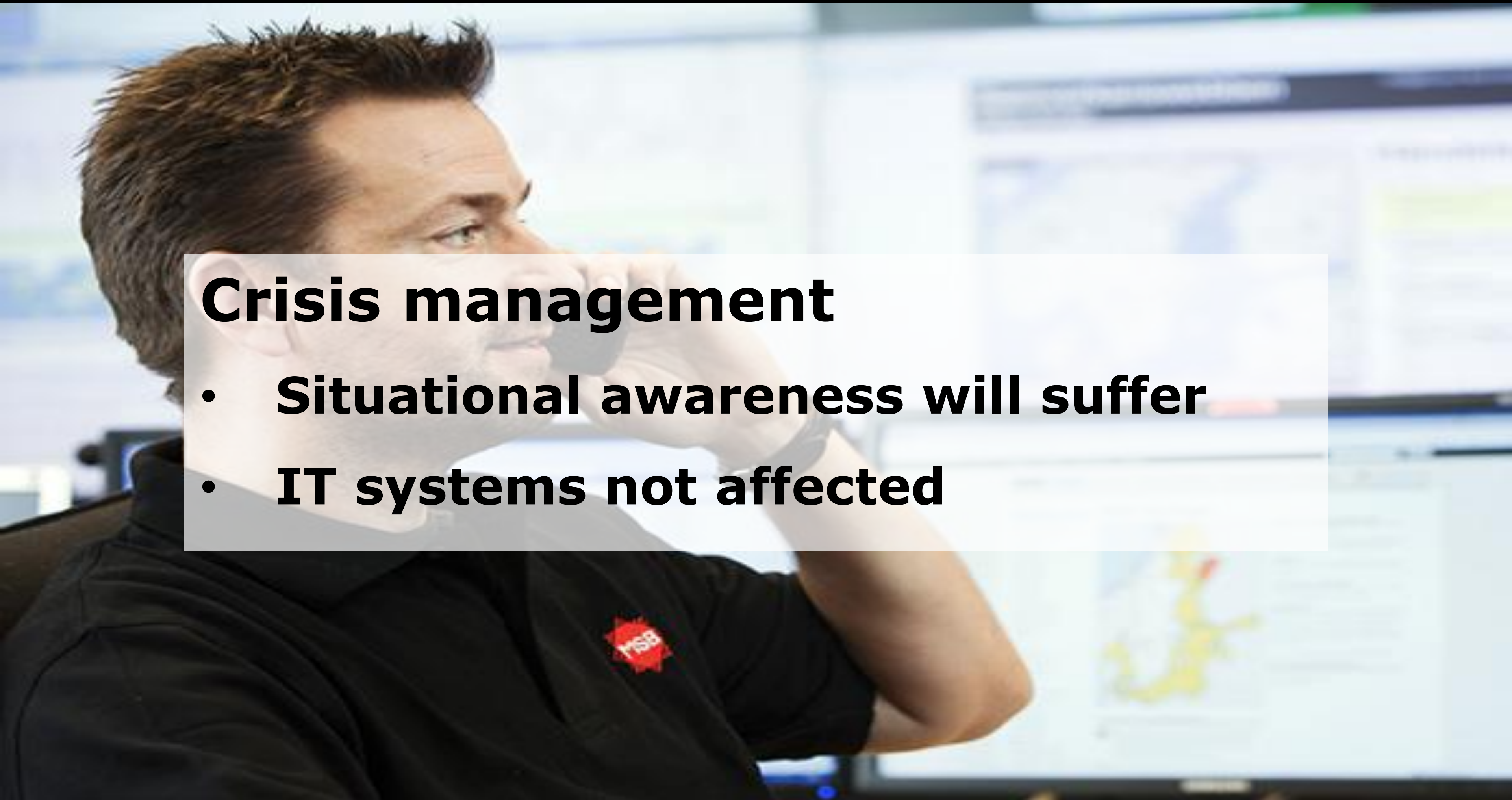

Crisis management

- **Situational awareness will suffer**
- **IT systems not affected**

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Scenario analysis

Summary

- Dependance of GNSS positioning is widely spread
  - Functions will be able to continue, although with decreased efficiency
- Timing is more critical
  - Redundant systems most often available
  - Will however drift with time

The scenario will likely lead to:

- Limited consequences for human life and health
- Severe consequences for the economy and the environment

Mitigation

- Need for proper knowledge of redundant systems
- Continuity planning

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Vikten av var och när

Samhällets beroende av korrekt tids- och positionsangivelse

Google ”Vikten av var och när” to find the report

Myndigheten för samhällsskydd och beredskap

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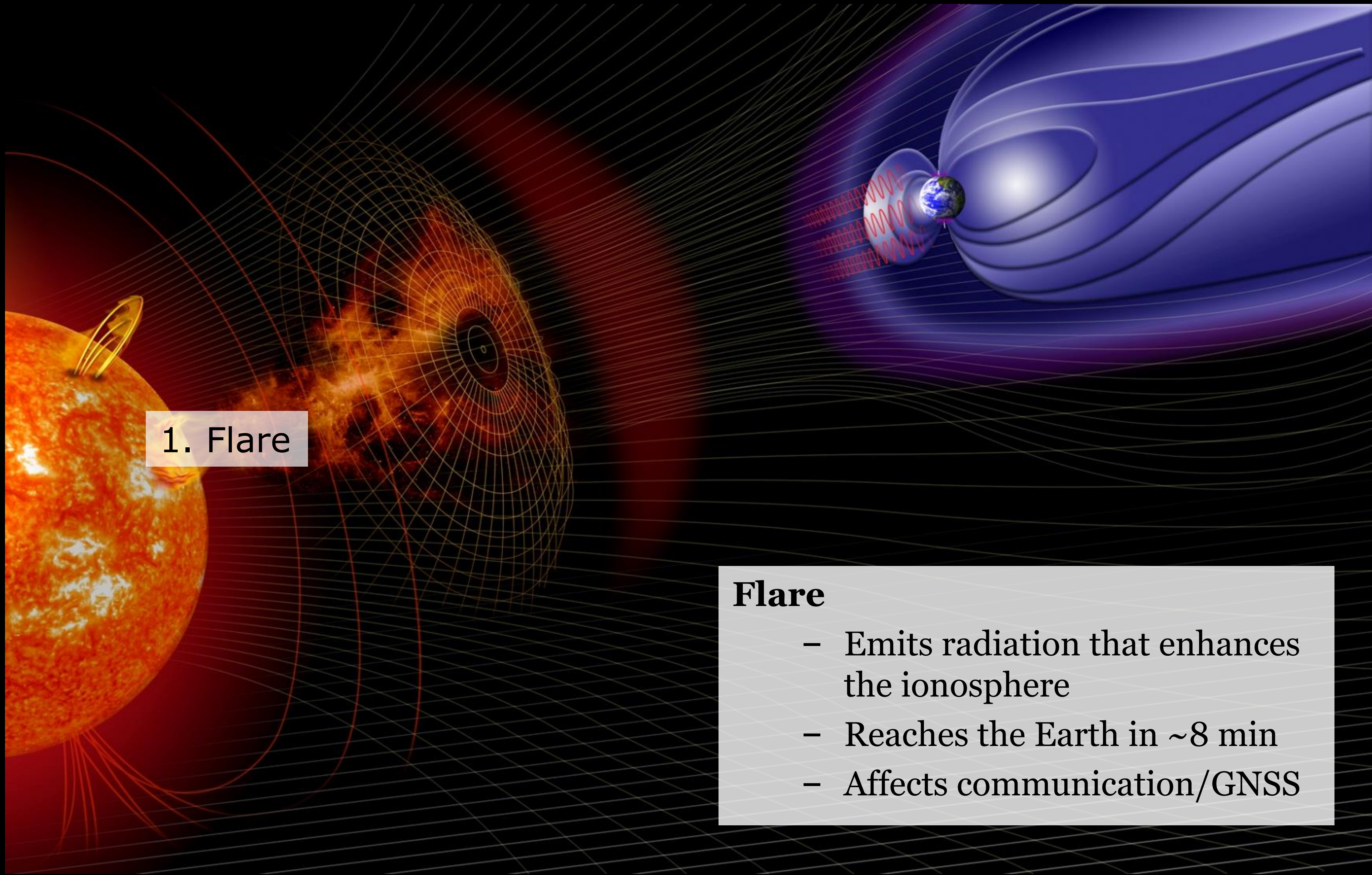
Two phenomena

- **Solar Wind**
  - Continuous flow of plasma
  - Potential to cause minor to medium geomagnetic storms

- **Coronal Mass Ejections (CME:s)**
  - ”Explosions” on the ”surface” of the Sun
  - Potential to cause extreme geomagnetic storms

CME = solar storm



Flare

- Emits radiation that enhances the ionosphere
- Reaches the Earth in ~8 min
- Affects communication/GNSS

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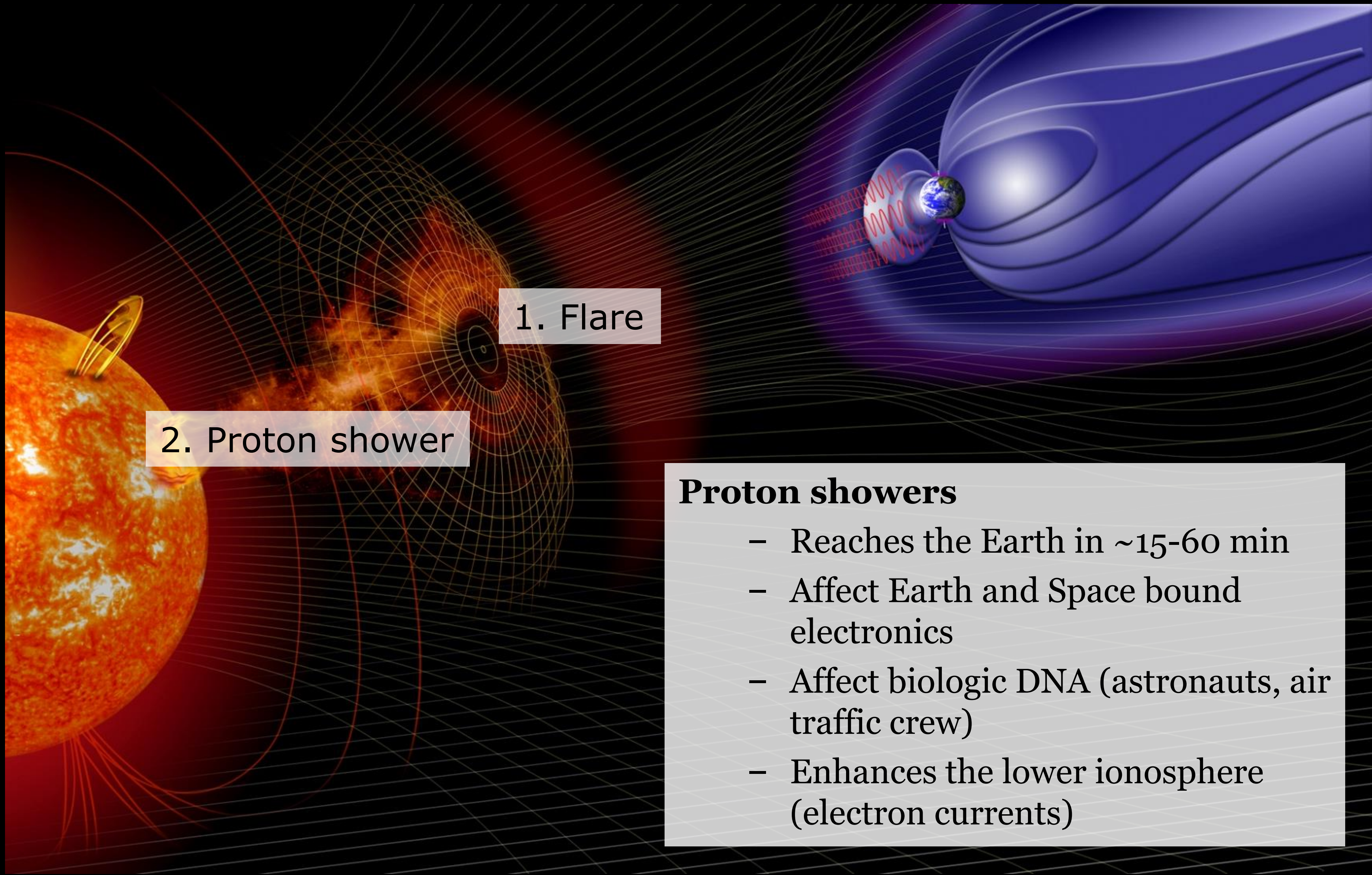
CME = solar storm



Proton showers

- Reaches the Earth in ~15-60 min
- Affect Earth and Space bound electronics
- Affect biologic DNA (astronauts, air traffic crew)
- Enhances the lower ionosphere (electron currents)

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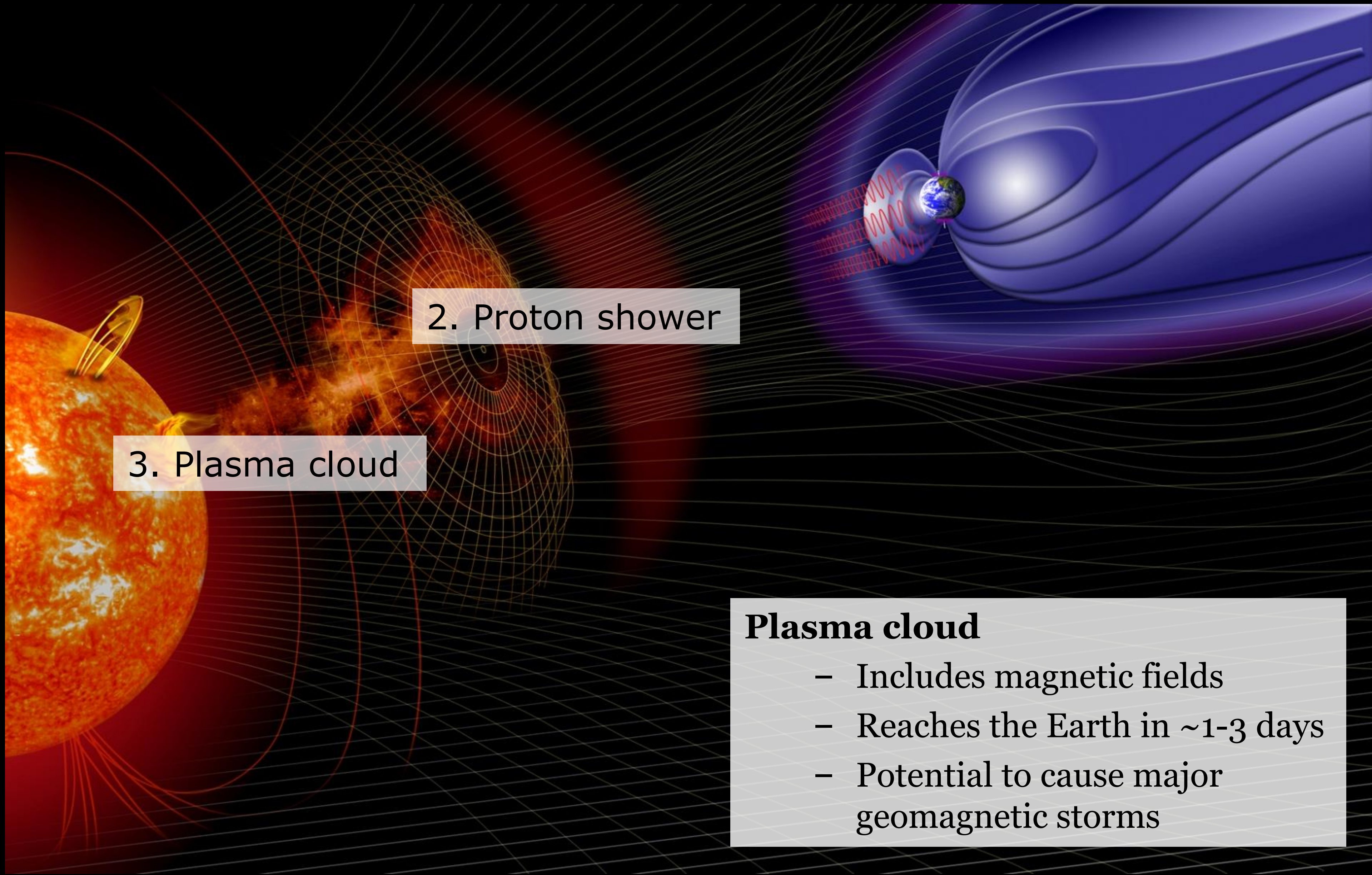
CME = solar storm



Plasma cloud

- Includes magnetic fields
- Reaches the Earth in ~1-3 days
- Potential to cause major geomagnetic storms

Impacts of space weather

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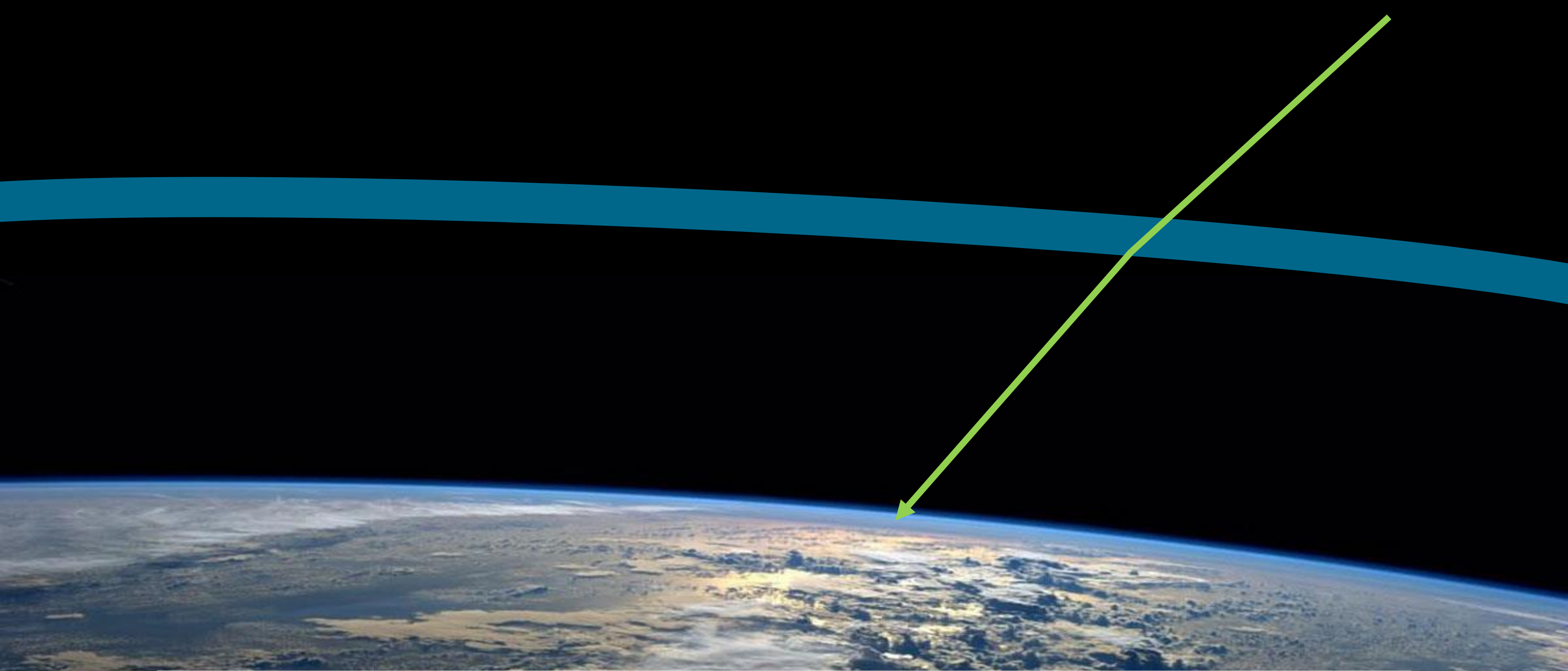
Solar storms – powerful ejections of plasma and electromagnetic radiation

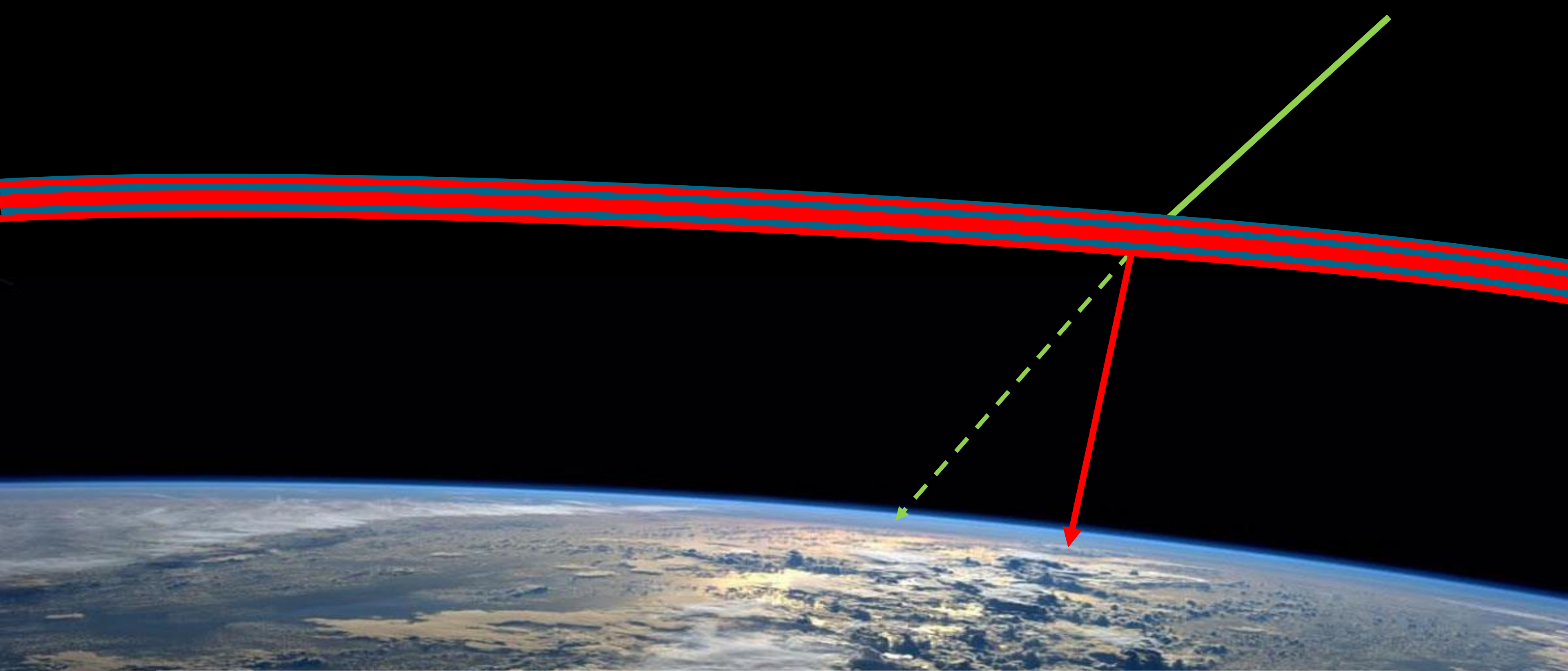
- **Affects**
  - high frequency radio communication
  - GNSS
  - satellite communication
  - air transportation
- **Induces currents into**
  - the power grid
  - pipelines
  - railways
- **Damages** satellite electronics

Impact on GNSS



- The charged plasma of the ionosphere bends the path of the signal
  - No space weather: average ionosphere is compensated for

Impact on GNSS



- The charged plasma of the ionosphere bends the path of the signal
  - No space weather: average ionosphere is compensated for
  - With space weather: models no longer accurate → receivers unable to calculate accurate position

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Why MSB?

- **The space threat** is unknown and the risks are relatively new
- We increasingly trust the technology, nonetheless within **vital societal functions**
- **Increased awareness** and **knowledge** is needed
- Need to integrate space weather with the work of **risk- and capability assessments** and **continuity methods**

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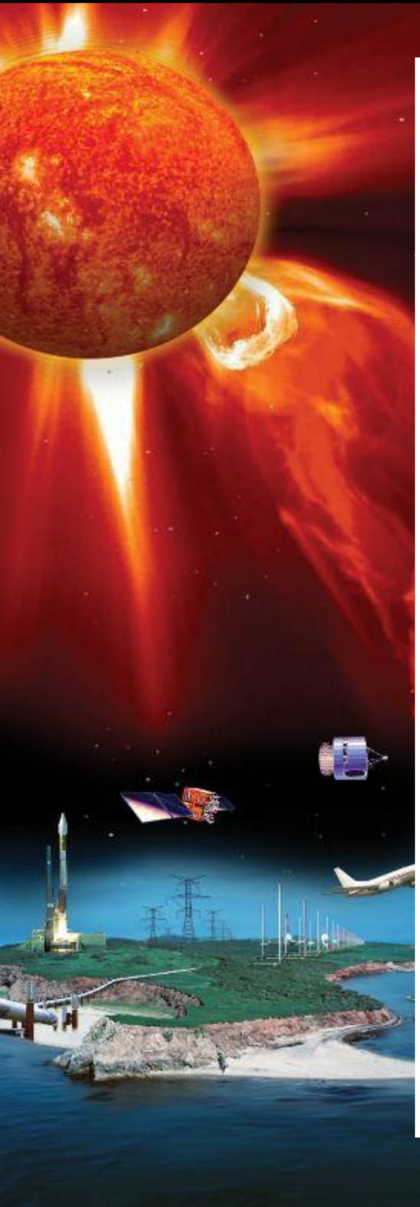
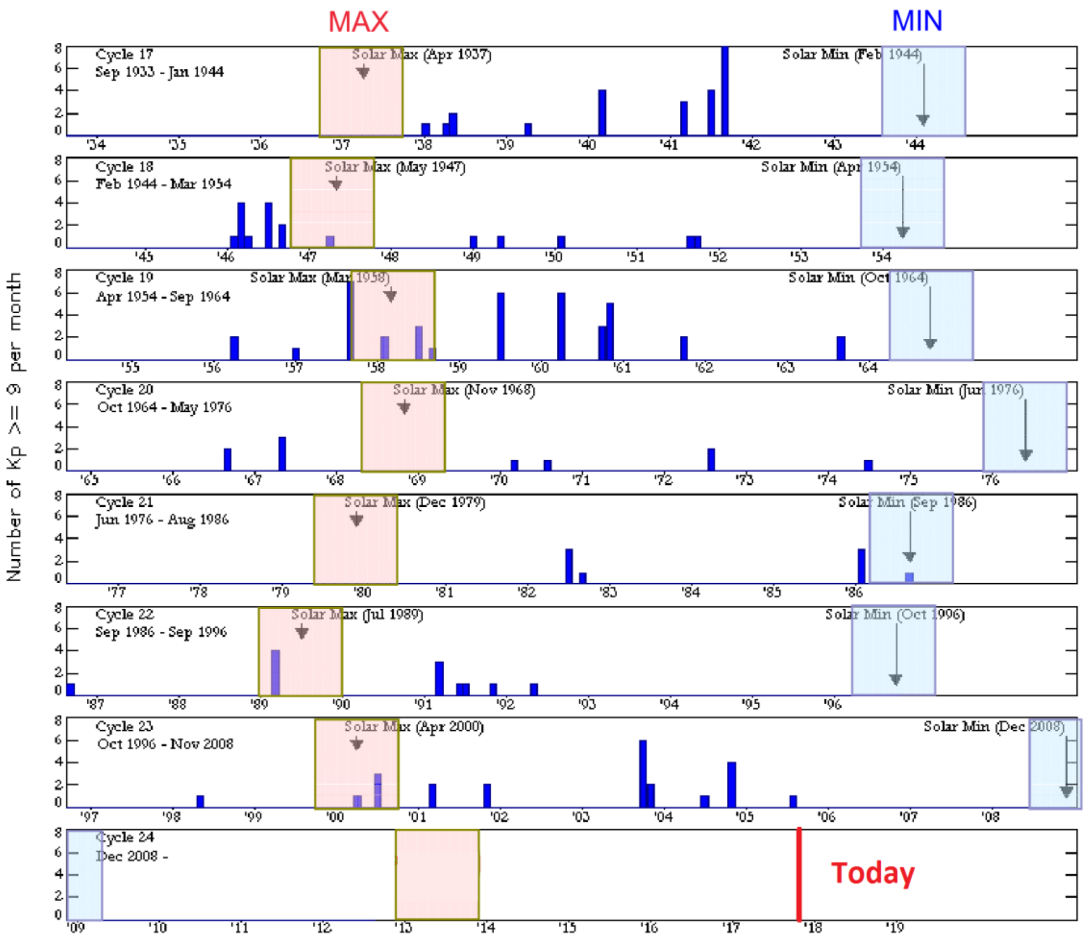


Periods with Kp >= 9



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