

TECHNOLOGY FOR HIGH TECH APPLICATIONS PROF DR ROBERT MEIJER – TNO, UVA



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University of Amsterdam:
Applied Sensor networks
Cyber Security
5G

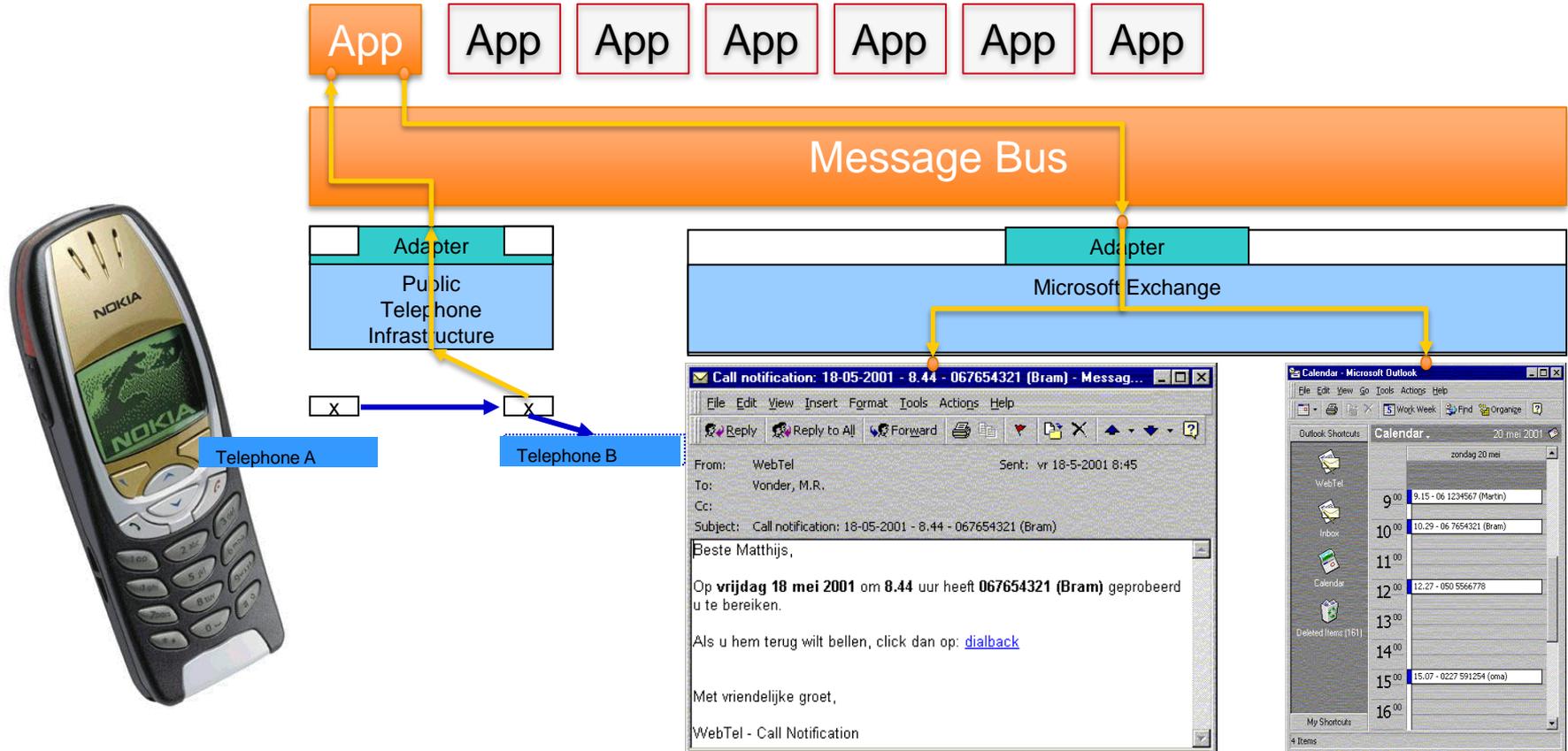


Drachten
3rd National Championship 2013



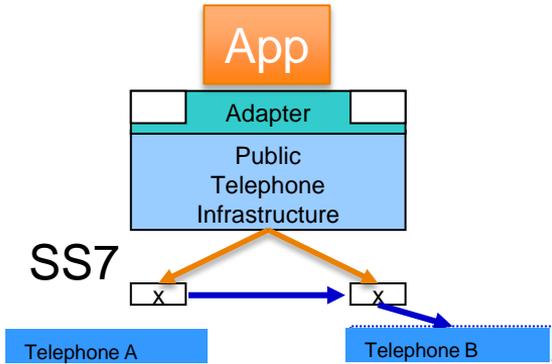
TNO: IJkdijk Foundation
www.ijkdijk.nl

1996-2003: SOFTWARE DEFINED NETWORKS

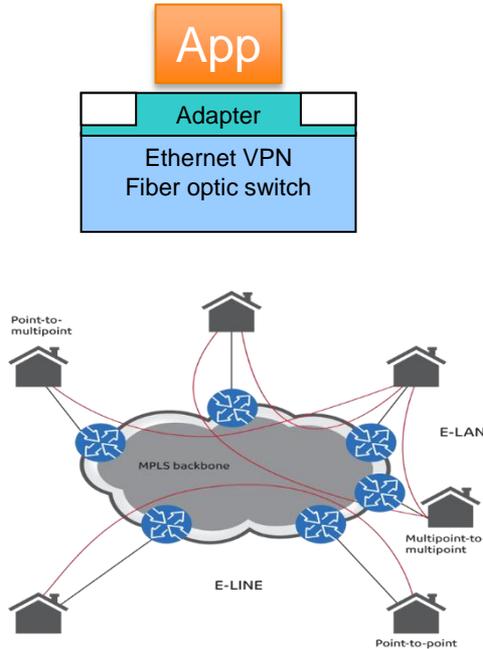


SOFTWARE DEFINED [NETWORKS, IT]

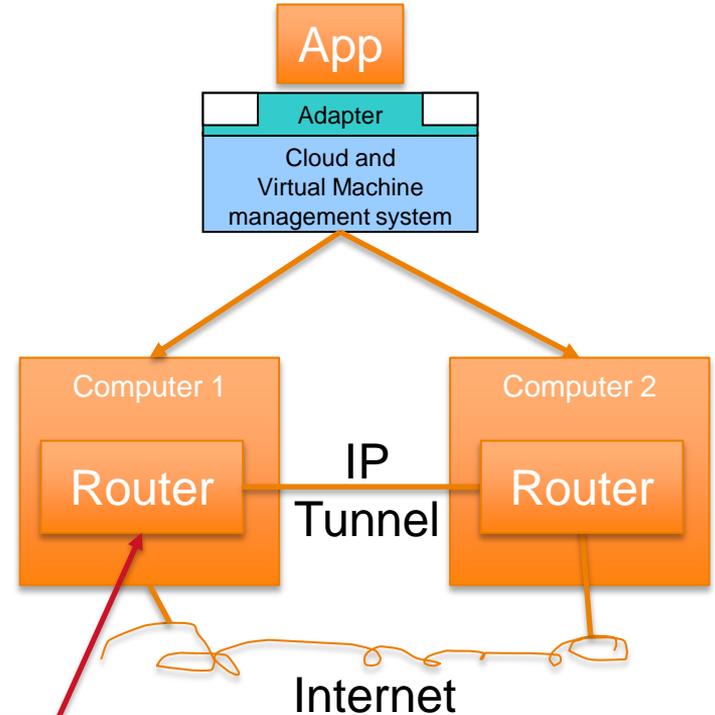
1996-2001



2003 - 2007

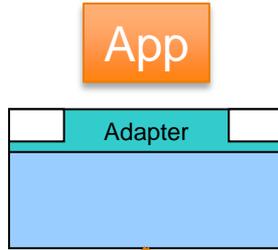


2007 - 2015



Network Function Virtualization - NFV

SDN: TUNNELS IN THE CLOUD



NETWORKWORLD



Amazon continues its international cloud expansion



RELATED

- Google adds two new cloud regions, plans 10 more
- Amazon's cloud conference - by the numbers
- Hottest products at AWS re:Invent 2015
- ...G Answers
- ...to turn on Windows 10's 'Find My Device' feature?

Alternative route

VIDEOS: INTERNET FACTORIES



1 world wide wide

2 programming
and compiling

3 it works

4 feedback

5 feedback world

6 SARNET
reliability

<http://youtube.com/user/ciosresearch>



› **SOFTWARE DEFINED NETWORK**
SOFTWARE DEFINED INFRASTRUCTURE



SOFTWARE DEFINED NETWORK- SDN

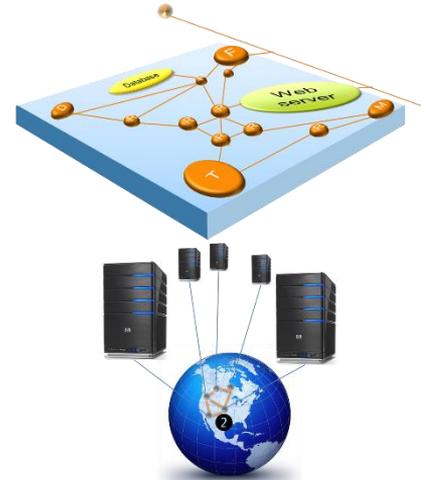
SOFTWARE DEFINED INFRASTRUCTURE - SDI



Prepare

```
Program new_web_front_end(DC) {  
  Rent(3)_computers on datacenter(DC);  
  Start computer(1) (2) (3) on  
    datacenter(DC);  
  Run router(1) (2) (3) on  
    computer_ (1) (2) (3) on  
    datacenter(DC);  
  Connect_router(1) (2) (3) on  
    datacenter(1) with  
    router(6) (7) (8) on  
    datacenter(DC);  
  Start services on computer (1) (2) (3);  
}
```

Execute SDI Program

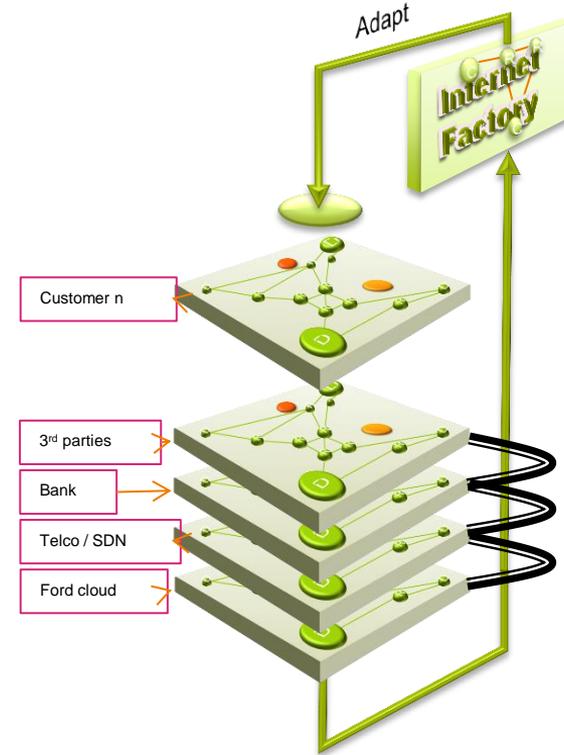


Deploy & operate
service

INTERNET FACTORIES

Software Defined Infrastructures

- › Generation
- › Adaptation
- › Linking
- › Globally



PhD 2014 UvA, Rudolf Strijkers, now at Swisscom

SCALING AND DISTRIBUTION OF ICT

Scaling and distribution

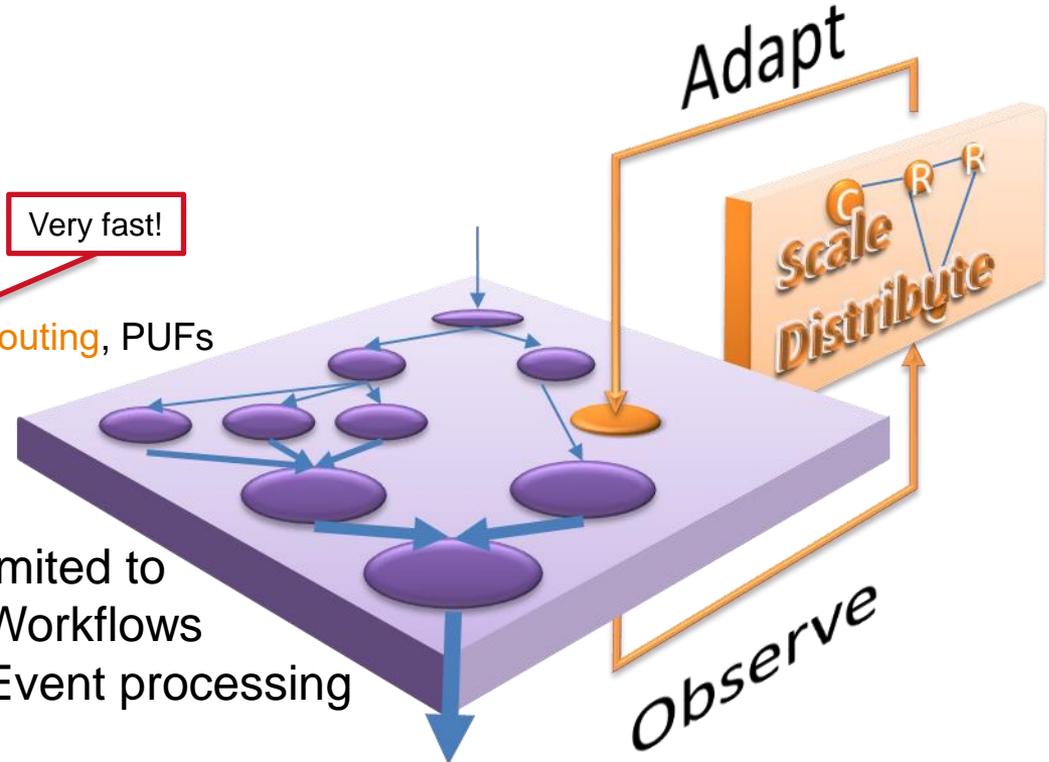
1. Scale
2. Distribute
3. Best paths, free flows, GPU's for routing, PUFs
4. Globally, continuously

Very fast!



PhD 2016 UvA, Marc Makkes, now at VU

- Is limited to
- Workflows
 - Event processing



SECURITY ADAPTIVE RESPONSE NETWORKS

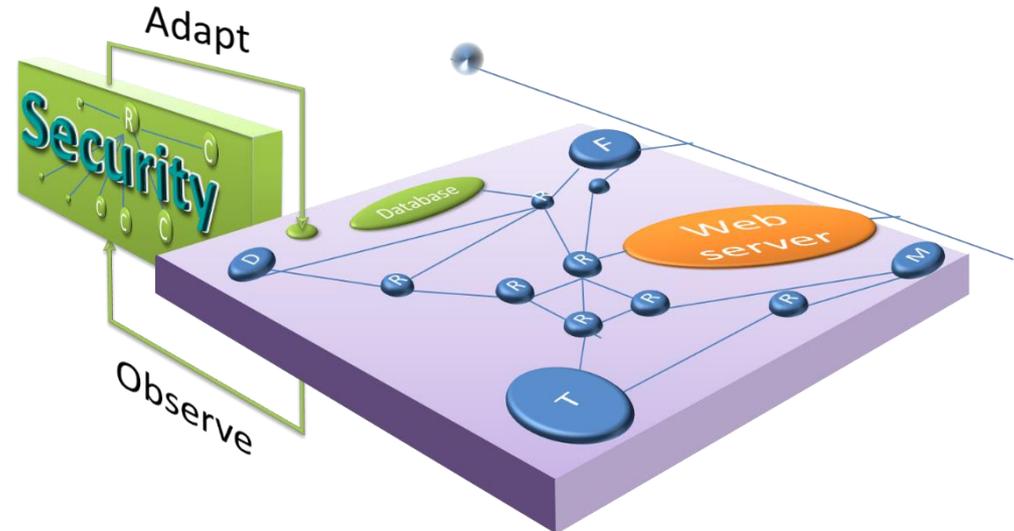
ciena. : the network specialist



TNO

Security of ICT

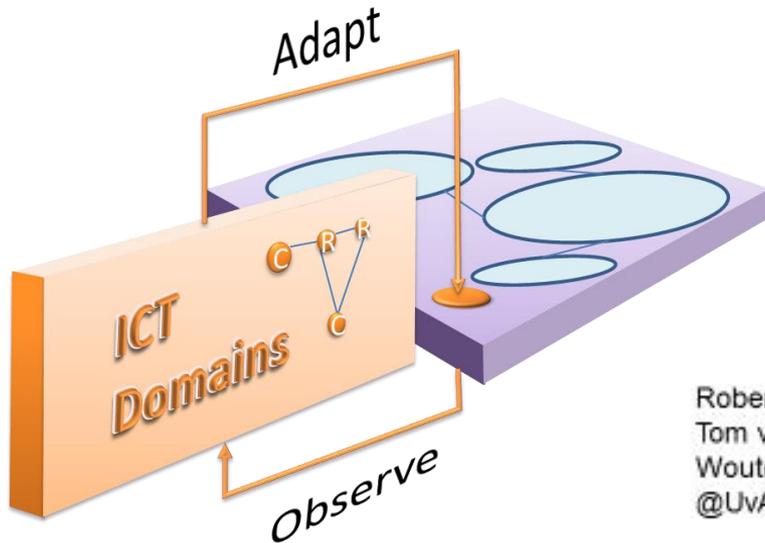
- SARNET: Security adaptive response networks
- Virtual and real (fiber) networks



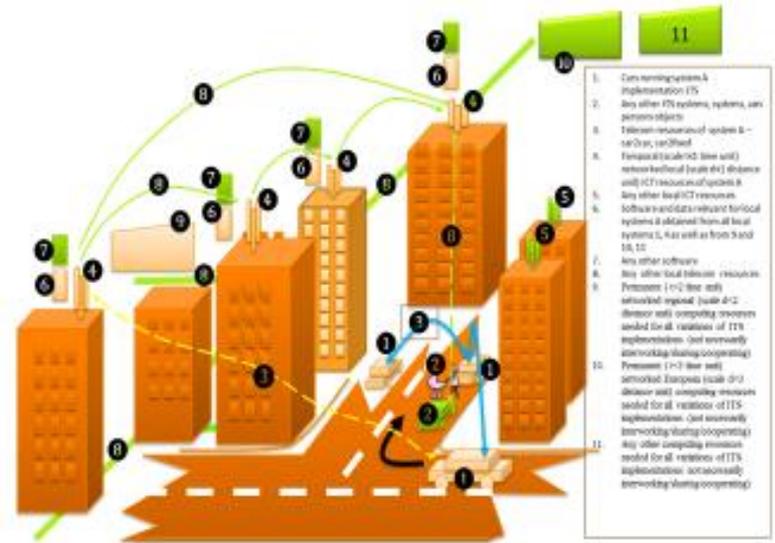
PhD UvA 2019, Ralph Koning,

ON THE MIND ... DATA DOMAIN ENFORCEMENT

C – ITS JURIDICAL REFERENCE MODEL



Robert Meijer
Tom van Engers
Wouter van Haaften
@UvA



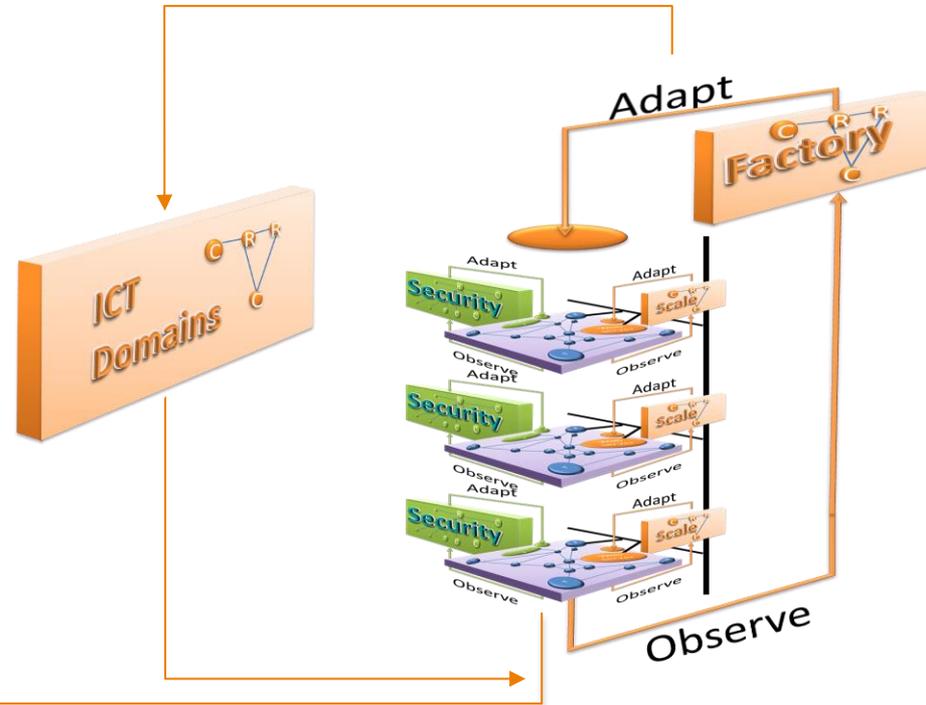
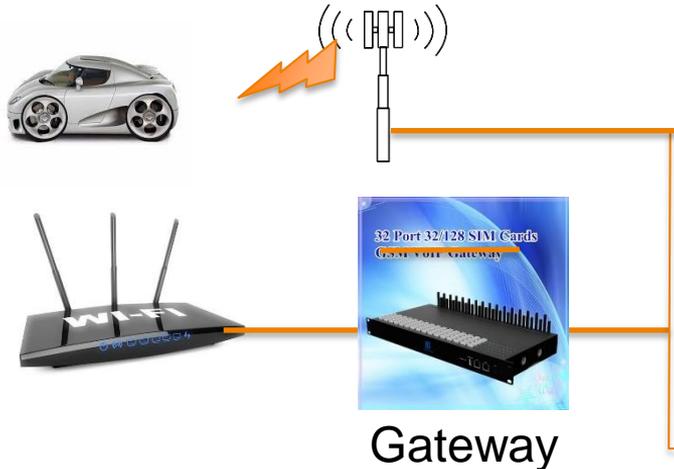
FUTURE INTERNET INFRASTRUCTURE:

-SECURE, SCALABLE INTERNETS IN THE CLOUD

- SDN TO CONTROL LAYER 2 CONNECTIONS BETWEEN CLOUD INTERNETS AND HOME/COMPANY GATEWAYS

› Pillars of security:

- › CPUs with PUF
- › Gateways
- › Layer two telecom networks



THE NEW TELCO BUSINESS MODEL



Customers pay
OTT



OTT 1

OTT 2

....

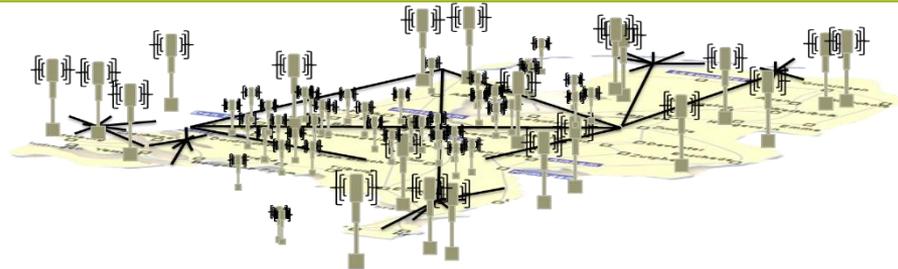
OTT n

OTTs pay
manufacturers
to use software

“Telco
equipment
manufacturers”
pay telco’s to
run install their
hardware

SOFTWARE

Telco owns
mostly dumb
layer 1 and 2



› SOFTWARE DEFINED NETWORKS

INTERNET IN MACHINES
BETWEEN

DEVICES ARE INTERACTING VIA THE CLOUDS



Devices you can print from:
Tablet, Phone, Chromebook, PC/Mac/Linux



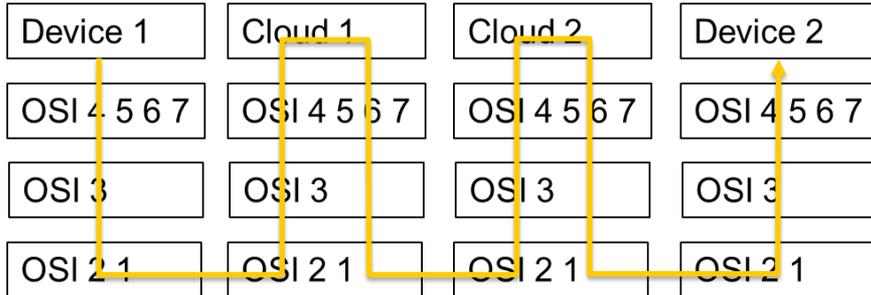
Google Cloud Print



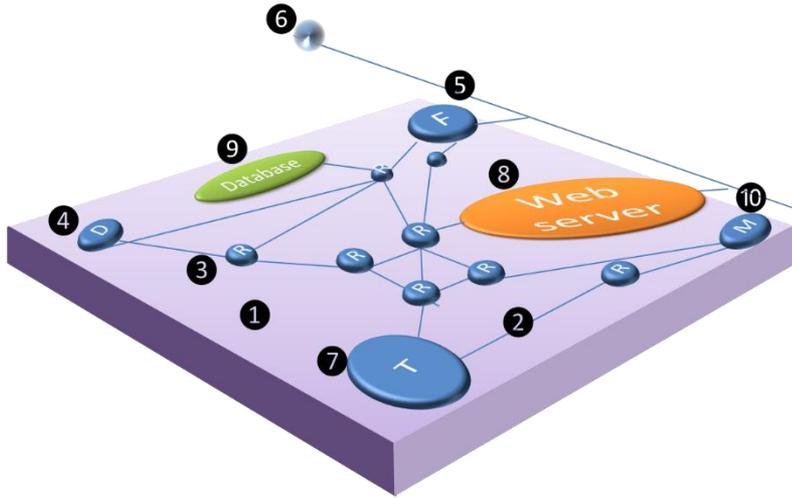
A PC with Chrome browser using a wired or WiFi capable printer.

B Cloud-ready printer.

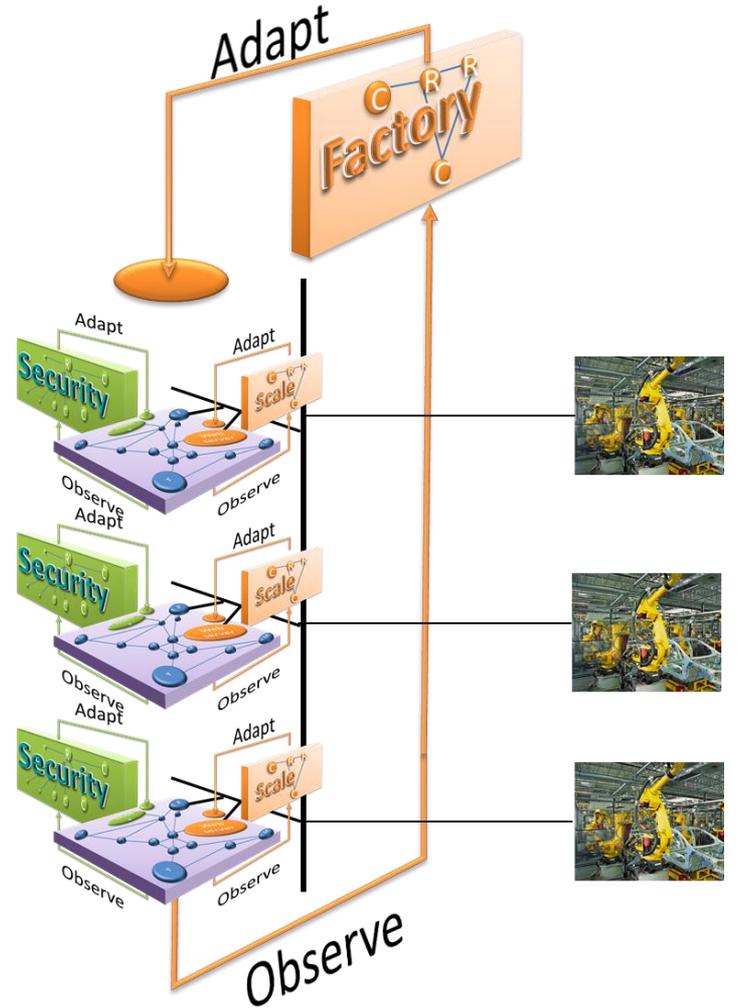
C Print Server with network printer.



(SERVICES) THAT CONTROL MACHINES

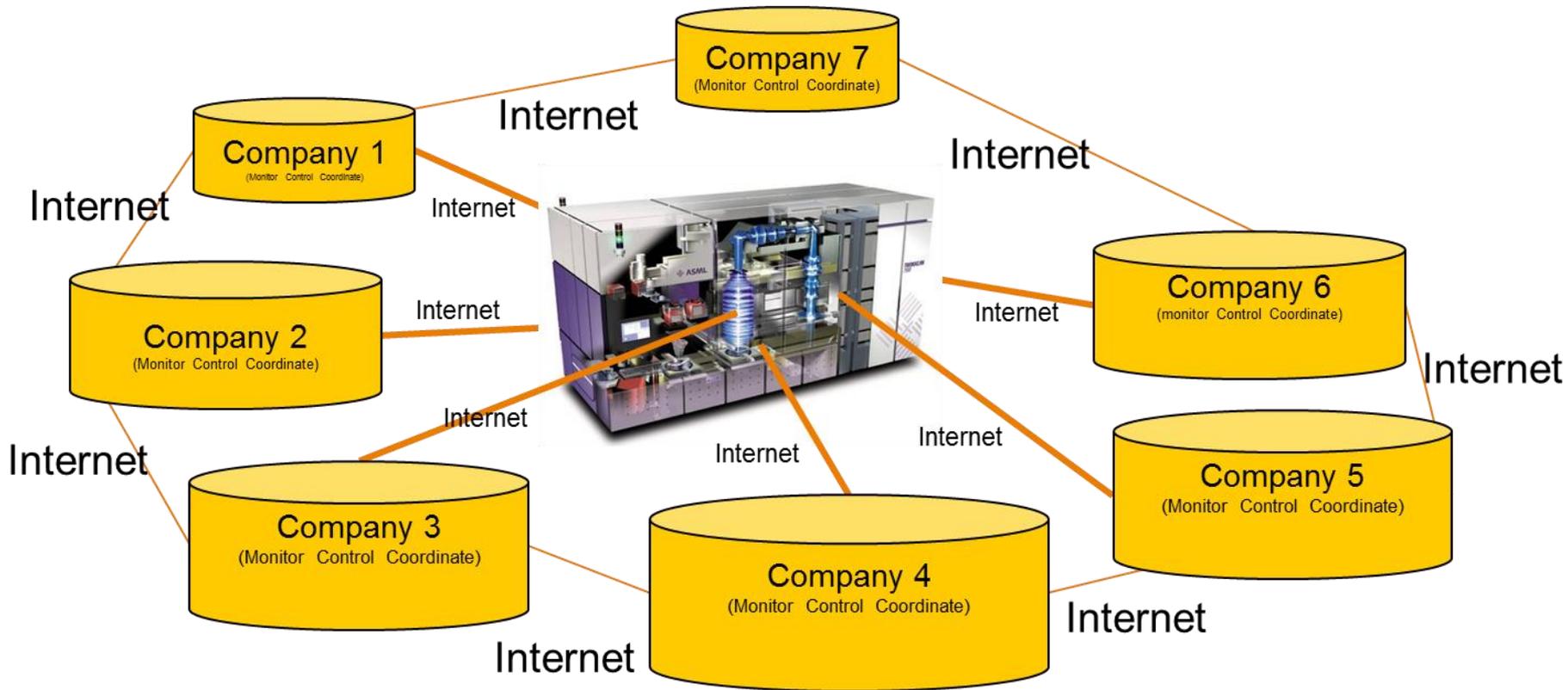


SMART FACTORY



FUTURE WAFER STEPPERS - 10⁶ WIRELESS SENSORS AND ACTUATORS





› **SOFTWARE TO DEFINE
COLLABORATIVE AUTONOMOUS
SYSTEMS (THINGS)**

TNO innovation
for life



DYNAMIC NETWORKED ARCHITECTURES

- › Compilers
 - › Self Programming
 - › Self Distribution
 - › Self Organisation
 - › Recursive Infrastructures
- › DNA



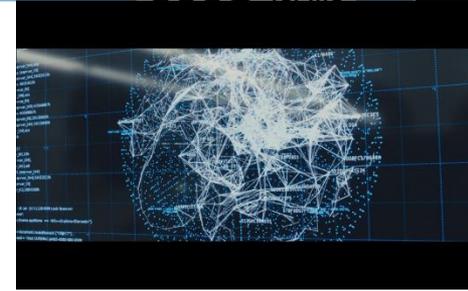
```
Program enlarge_network() {  
  rent(3) computers on datacenter(11);  
  Start Computer(1)(2)(3) on datacenter(11);  
  Run router(1)(2)(3) on computer(1)(2)(3) on datacenter(11);  
  Connect_router(1)(2)(3) with router(6)(7)(8) on datacenter(11);  
}
```

THE SDI CAN BE SO DYNAMIC THAT THE PROGRAM IS THE ONLY THING WE UNDERSTAND

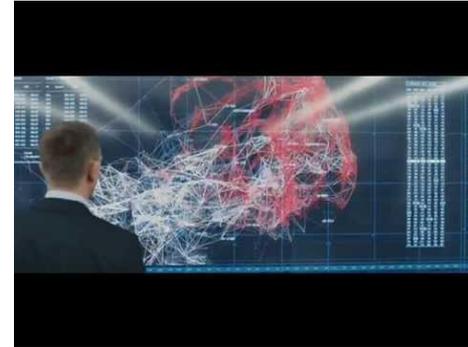
```
Program new_web_front_end(DC) {  
  Rent(3)_computers on datacenter(DC);  
  Start computer(1) (2) (3) on  
    datacenter(DC);  
  Run router(1) (2) (3) on  
    computer_(1) (2) (3) on  
    datacenter(DC);  
  Connect_router(1) (2) (3) on  
    datacenter(11) with  
    router(6) (7) (8) on  
    datacenter(DC);  
  Start services on computer (1) (2) (3);  
}
```

- › PROGRAM →
Dynamic
Network
Architecture
- › DNA

How it
currently
works



How it
transforms

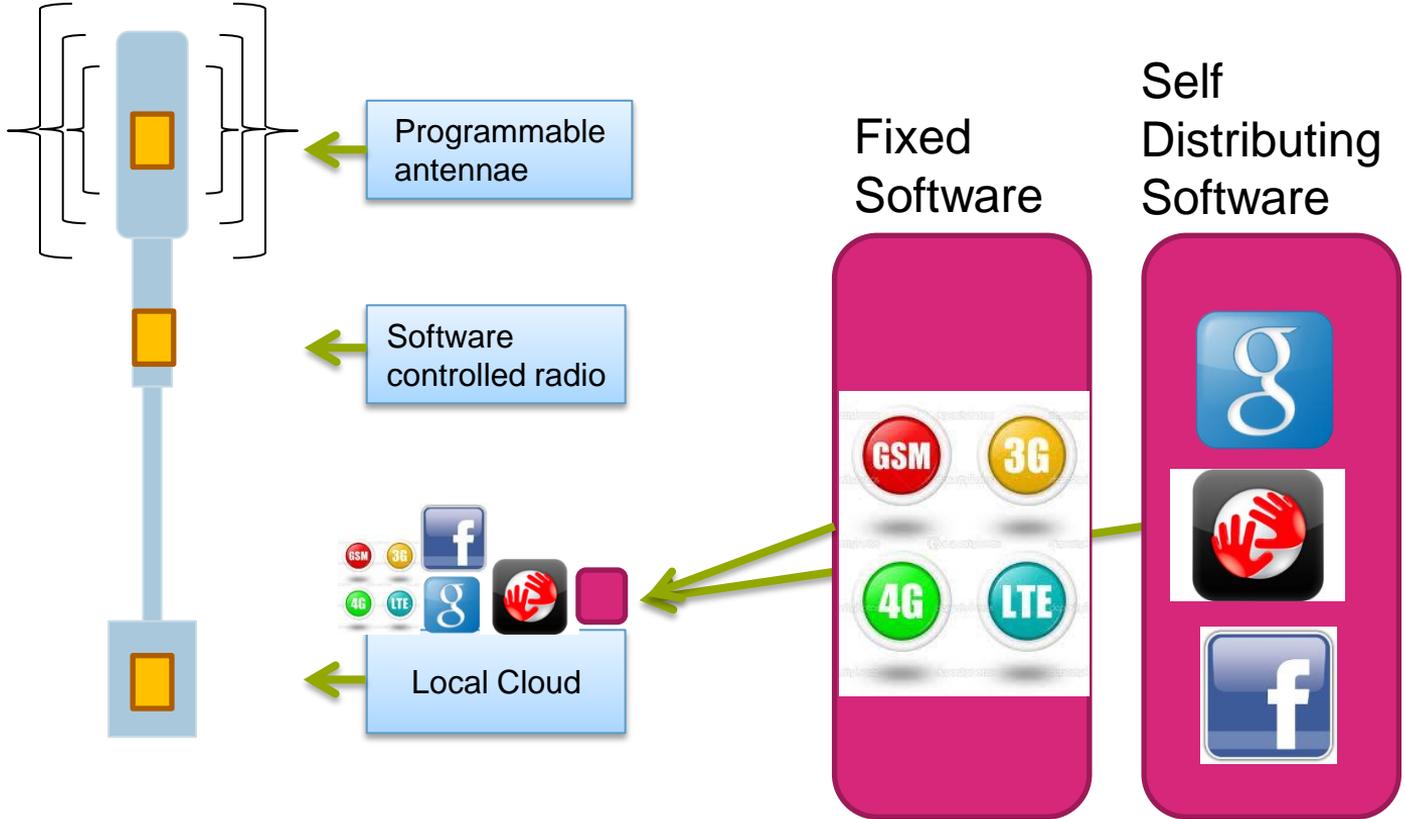


How it can be
understood

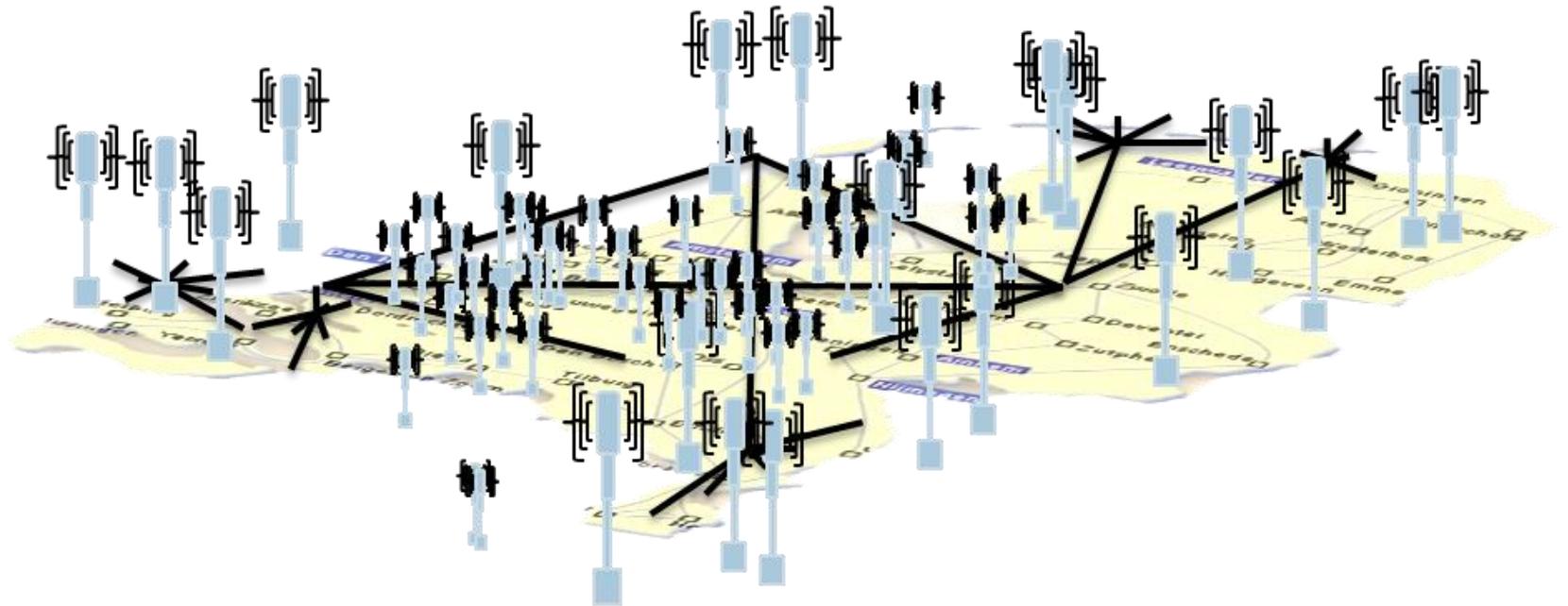


007: "He hacked me"

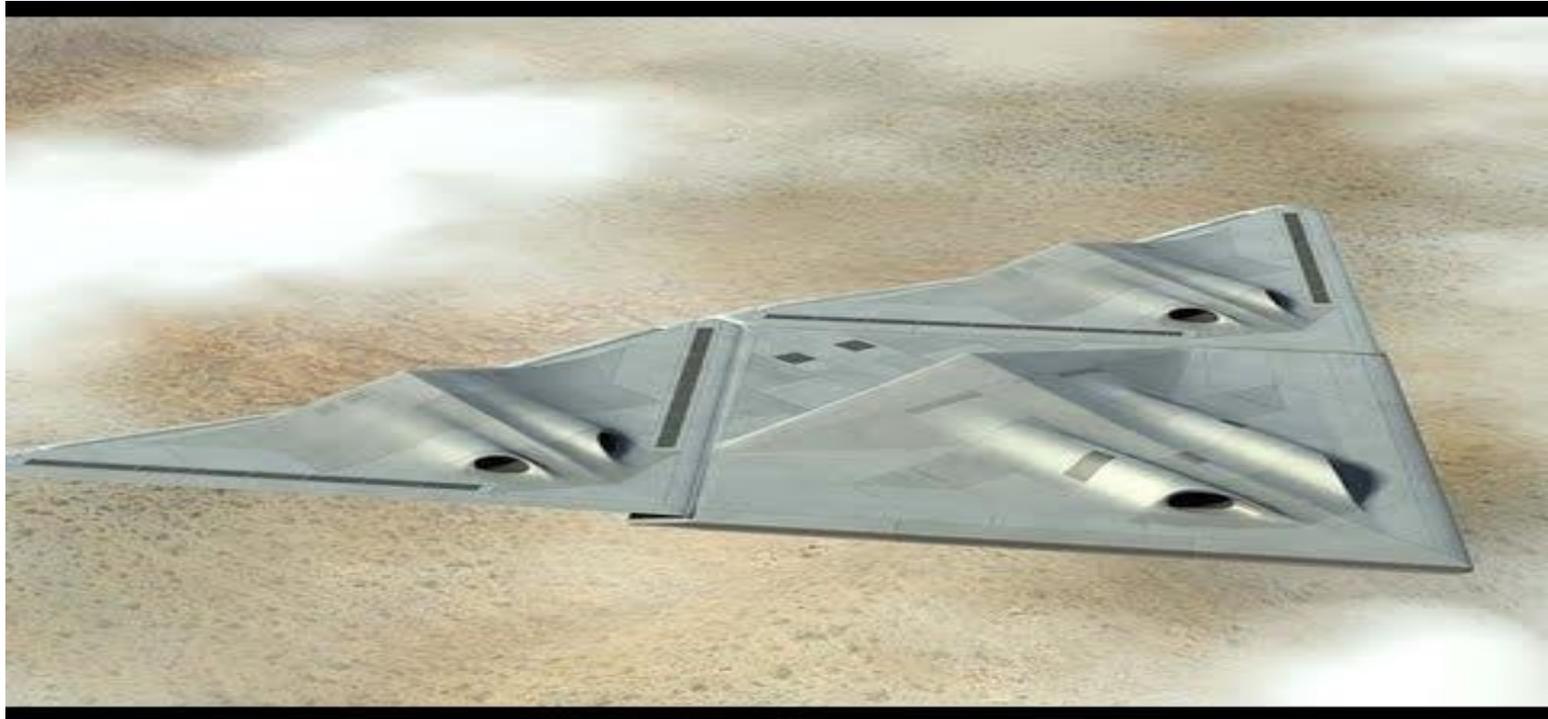
PROGRAMMABLE PARTS



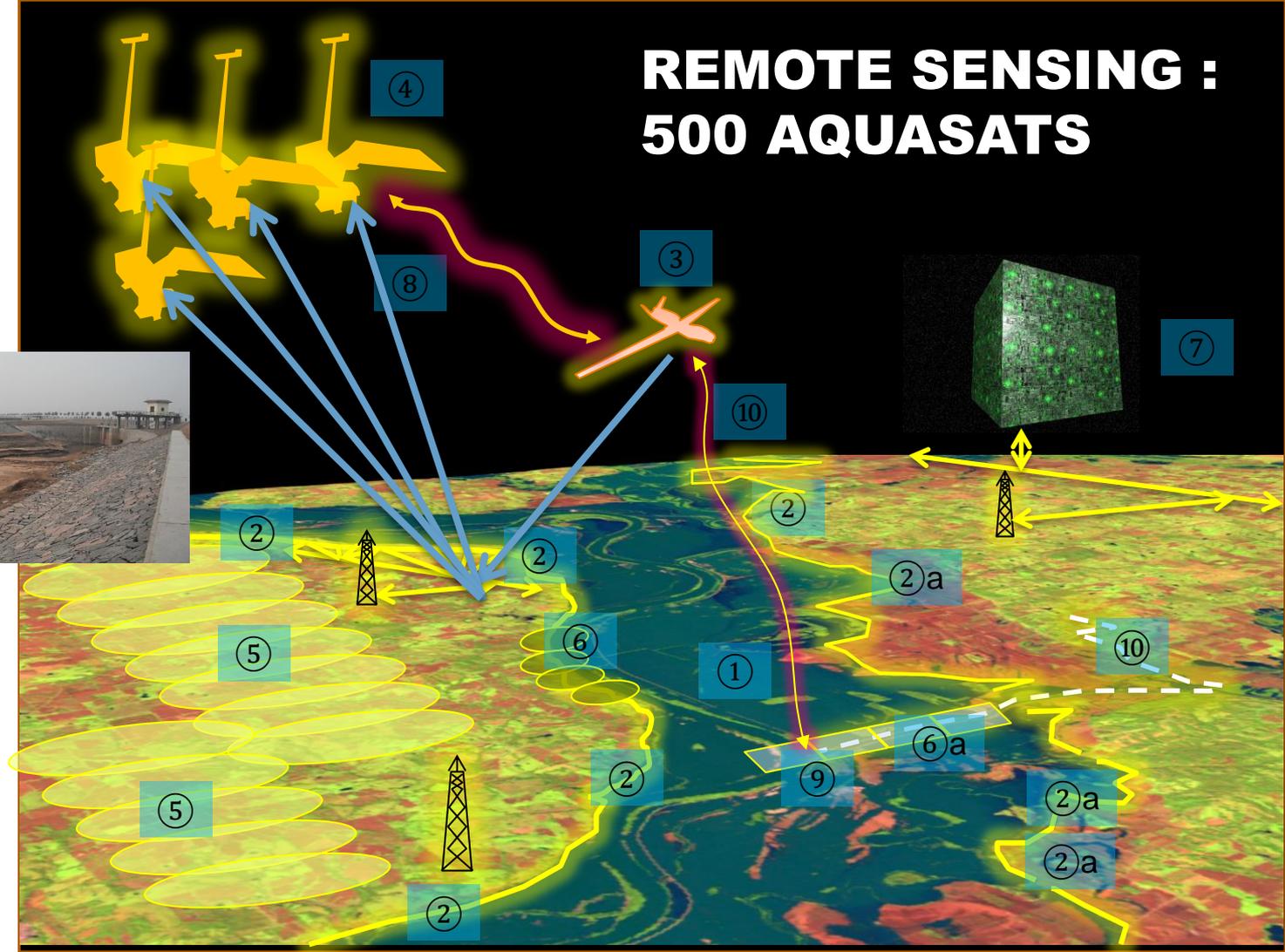
SELF DISTRIBUTING COLLABORATING PARTS



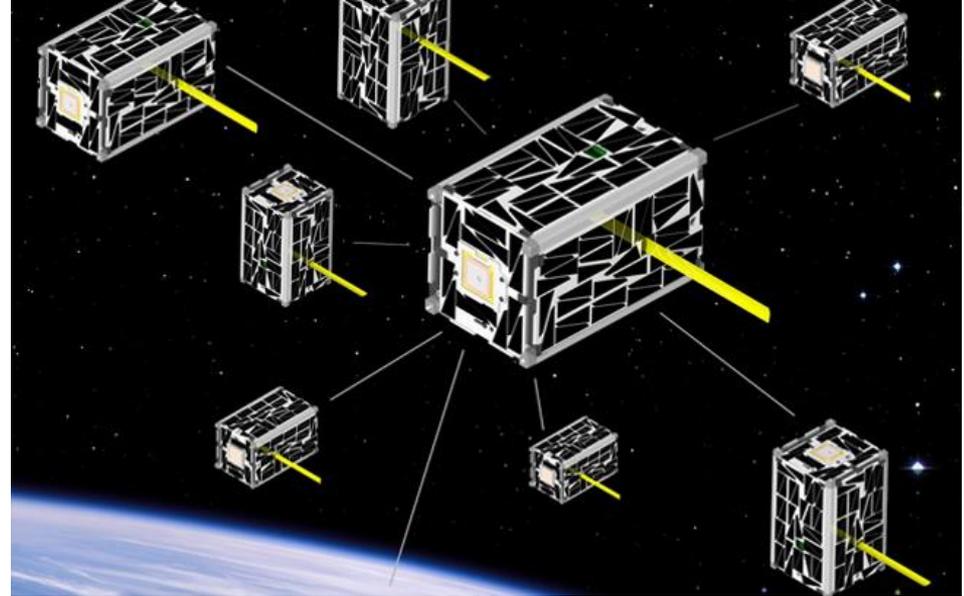
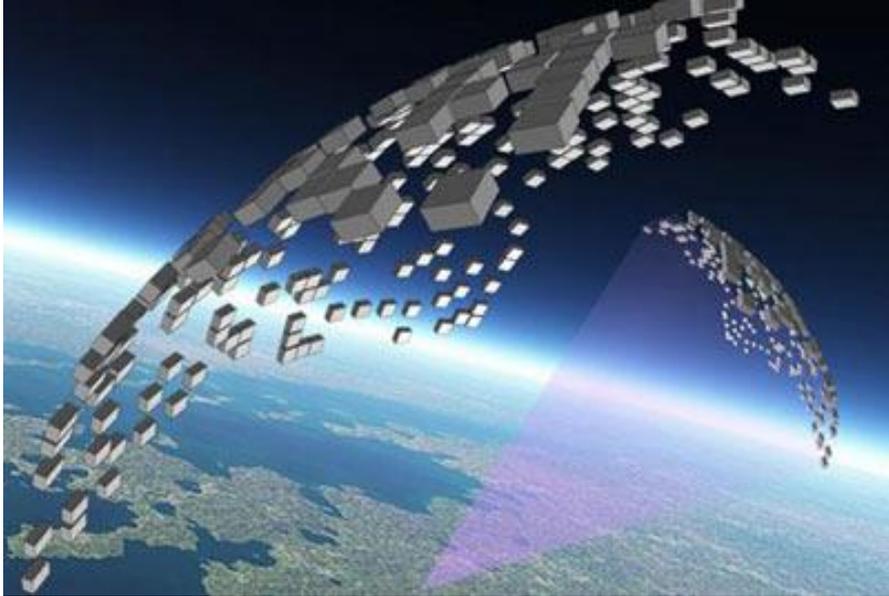
COOPERATING DISTRIBUTED AIRCRAFT



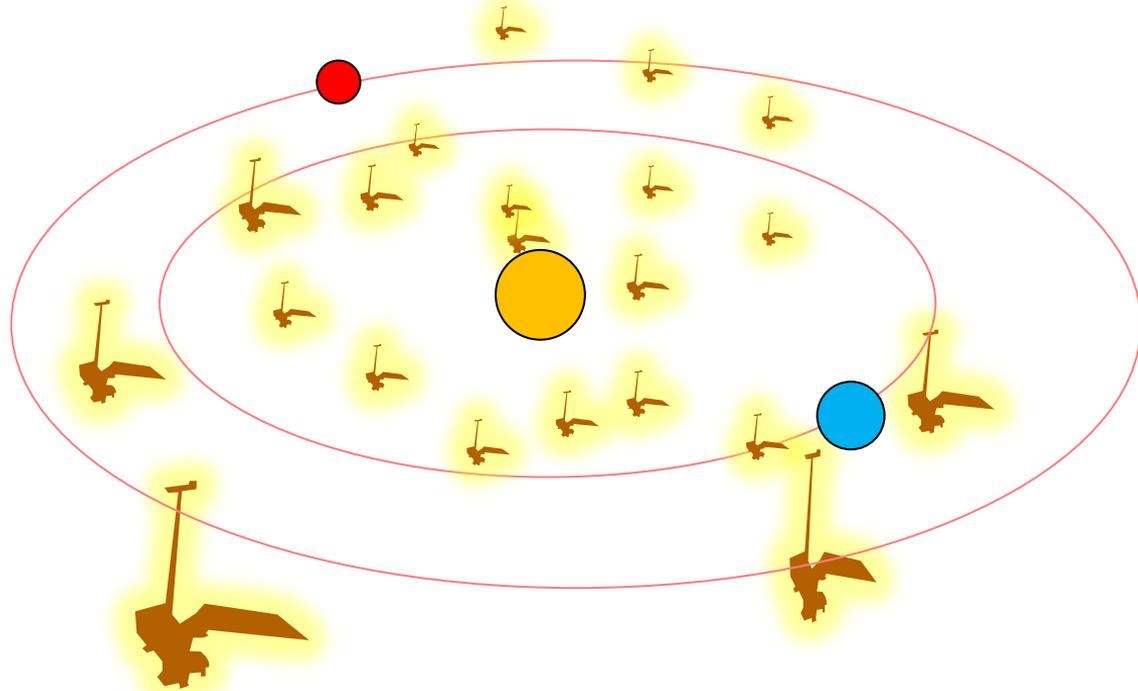
REMOTE SENSING : 500 AQUASATS



COOPERATING SATELLITES ON A CHIP, COOPERATING CUBESATS



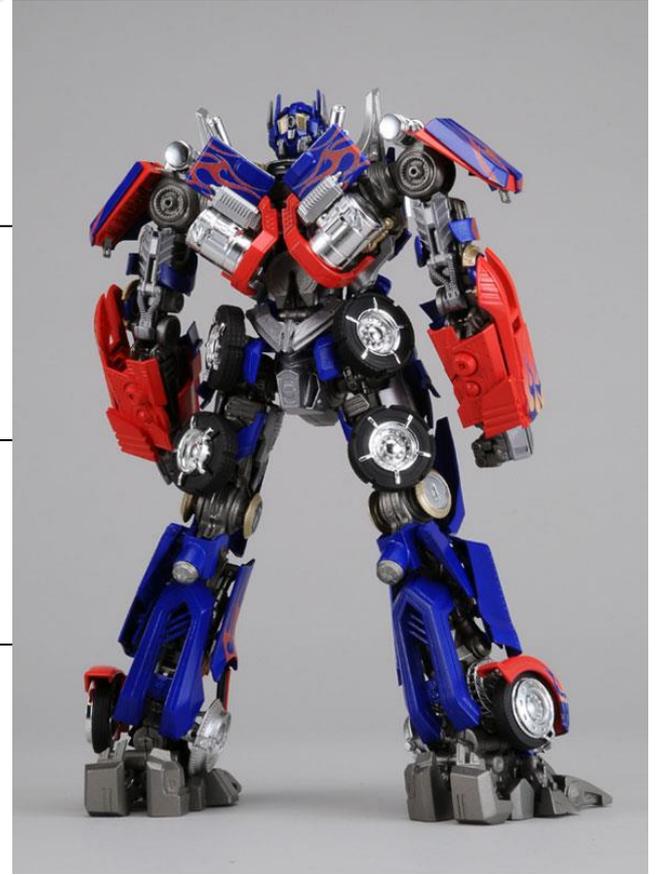
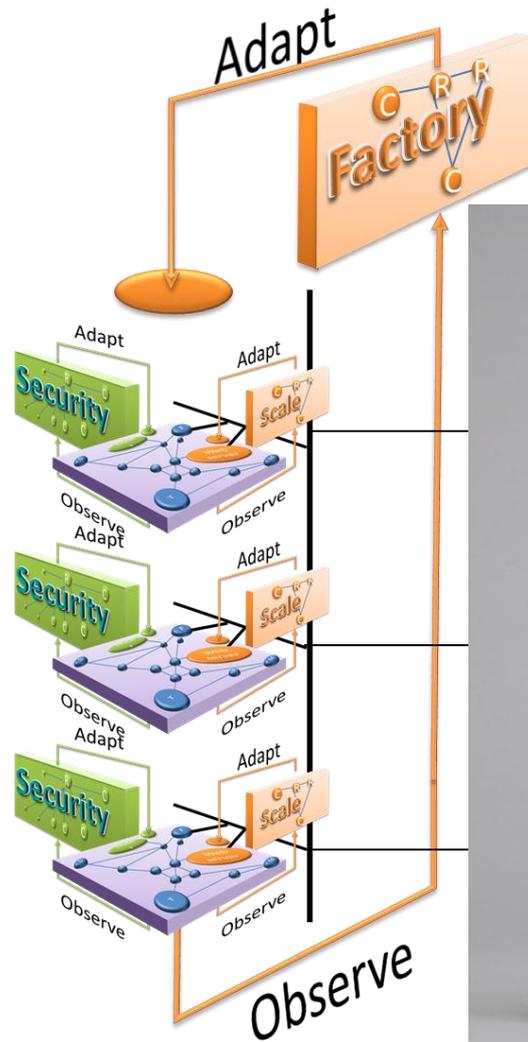
INTERPLANETARY TELECOMMUNICATION SYSTEM



MULTISCALE COOPERATION



MULTISCALE COOPERATION



MULTISCALE COOPERATION

DNA



- **THANK YOU,**

- › **SDN IS A TECHNOLOGY**

- **FOR CYBER SECURITY**
- **TO CREATE HIGH TECH APPLICATIONS**
- **THAT INVERTS THE TELCO BUSINESS MODEL**

TNO innovation
for life



› Q? A?

