

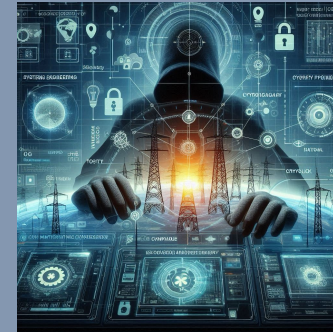
UNIVERSITY OF OSLO

Master's program in
Security for Cyber Physical Systems



Paal E. Engelstad,
Prof./PhD
paal.engelstad@its.uio.no

Kjeller, August 13, 2025



UNIVERSITY OF OSLO



Department of Technology Systems (ITS)
Campus Kjeller

WELCOME DAYS at ITS – PROGRAM

Wednesday,

10:00 – 10:10 **Welcome & brief introduction to ITS**

Cecilie R. Denby, Head of Department

10:10 – 10:25 **ITS: What do we teach and how?**

Matylda N. Guzik, Head of Education

10:25 – 10:45 **Essentials: All you need to know now**

Kaja Mosserud-Haavardsholm, Administrative Head of Studies

10:45 – 10:50 **QR-code: Trying to know you better**

11:00 – 12:00 **Meeting with the ITS master program/study direction coordinators & lecturers**

■ Master Students in Security of Cyber-Physical Systems

Paal Engelstad

■ Master Students in Cybernetics and Autonomous Systems

12:00 – 13:00 **Lunch**

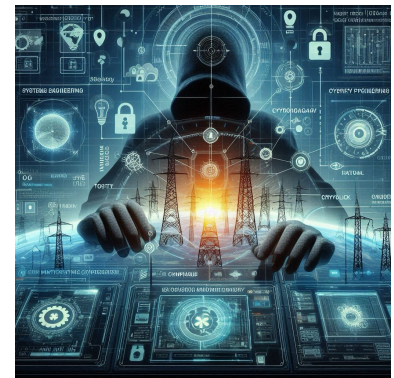
13:00 – 16:00 **Get to know each other and get to know ITS: Part I**

ITS staff and master students

Thursday,

13:00 – 16:00 **Get to know each other and get to know ITS: Part II**

ITS staff and master students



Department of Technology Systems (ITS)

Where are we located?

- Getting here
 - Direct bus from Blindern
 - Getting here: 08:25 or 12:40
 - Return: 13:15 or 16:00
 - Or check your Ruter app:
 - Train to Lillestrøm + bus
 - Bus 340
 - etc
- Many courses at Blindern



Your schedule for the first semester

	Monday	Tuesday	Wednesday	Thursday	Friday		
08:15 - 09:00						TEK4000 Kjeller 2 x 3_day_seminars: TBD	
09:15 - 10:00	TEK5370 Kjeller 21 .Aug.(Josef) 4 Sept (Shujun) 12 Sept (Shujun) 3 Oct (Shujun) ... etc... Videos offered						
10:15 - 11:00		IN4210 Blindern					
11:15 - 12:00							
12:15 - 13:00							
13:15 - 14:00					IN4210 Blindern		
14:15 - 15:00							
15:15 - 16:00							
1. semester	TEK 5370 Grid, Smartgrid and IoT		IN 4210 Network and Comm. Security		TEK 4000 Systems Engineering		
	10 credits		10 credits		10 credits		

TEK4000
Kjeller

 2 x 3_day_seminars:

 TBD

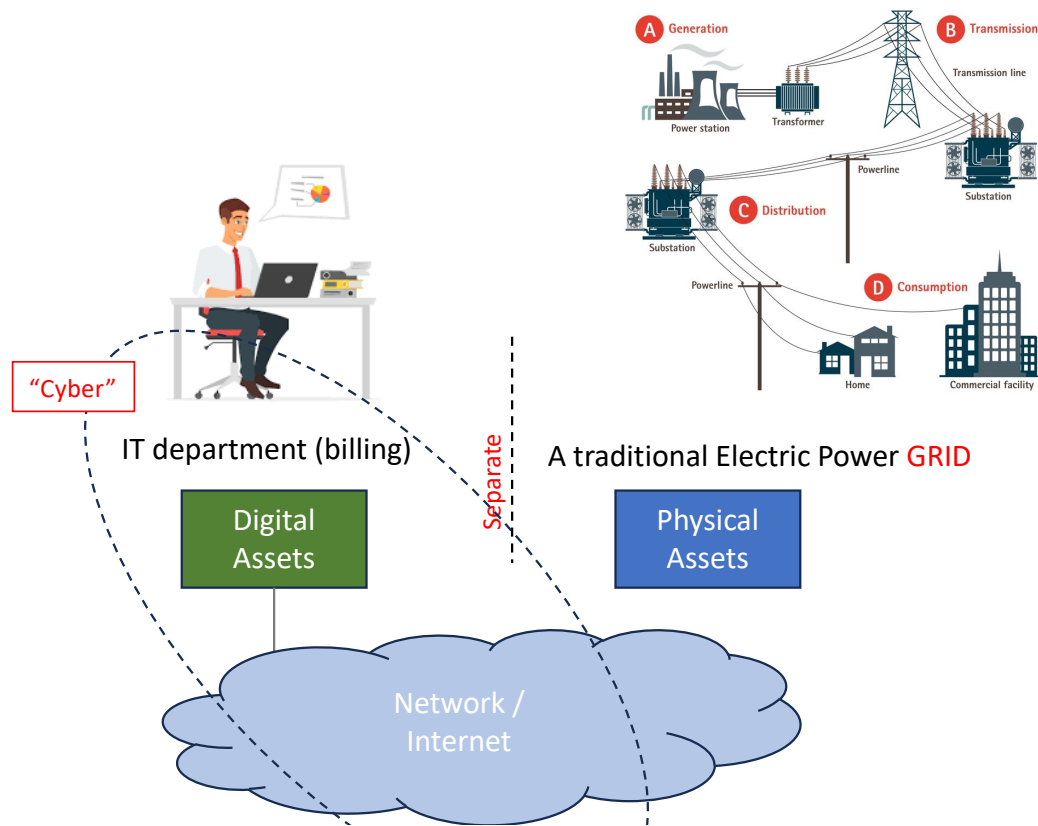
Agenda

- General info (Kjeller vs Blindern)
- What is Cyber Physical systems anyway? 
 - Let's start by looking at **Cyber Security** first
 - Security for Cyber Physical Systems (S4CPS)
- Why do we need a Master's for Security in Cyber Physical systems?
- Choices you have to make
 - Long vs Short Master thesis
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What is Cyber Physical systems, anyway?

- Traditionally Digital and Physical Assets are separate.

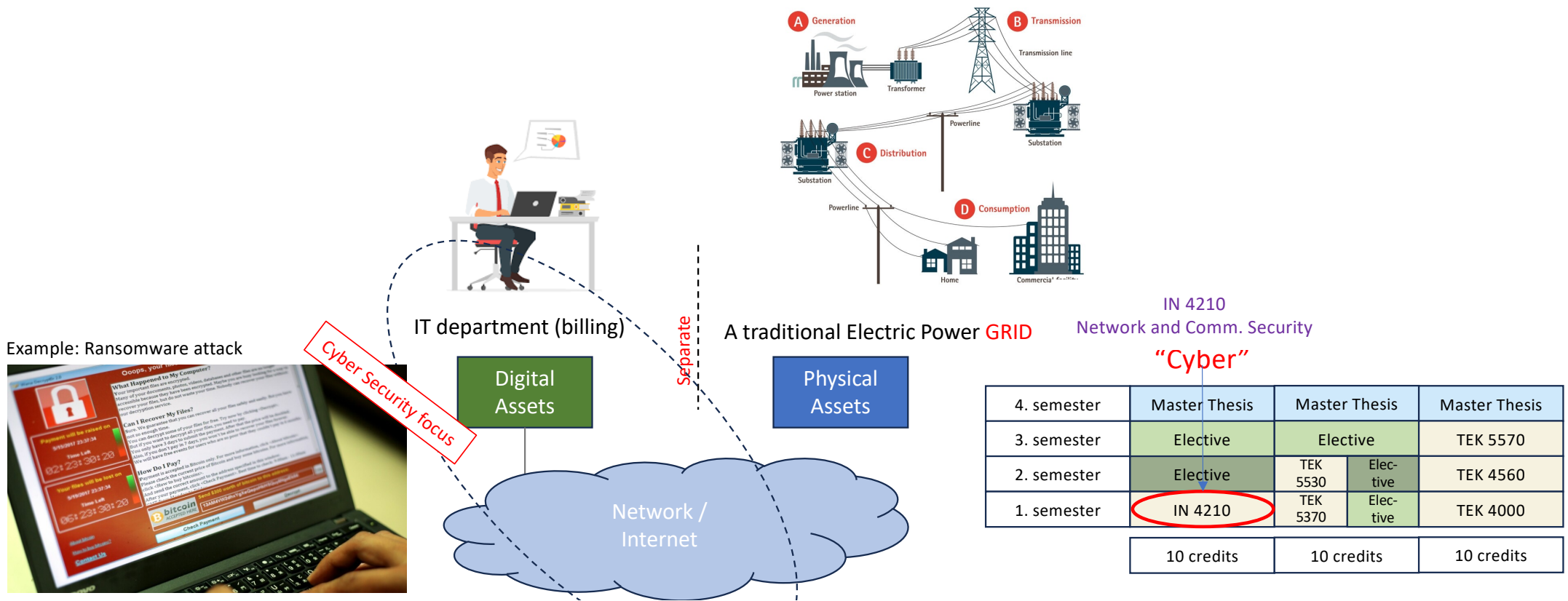
Example from Electric Power Supply Company (Distribution System Operator – DSO):



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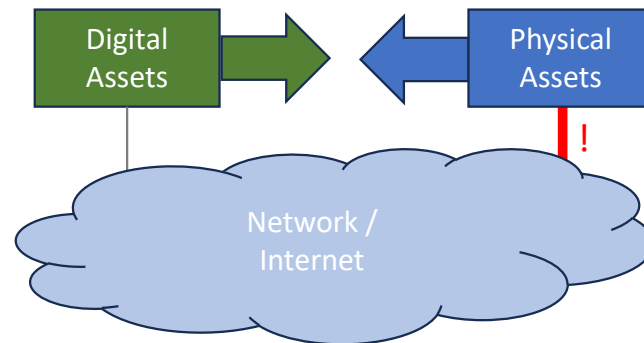
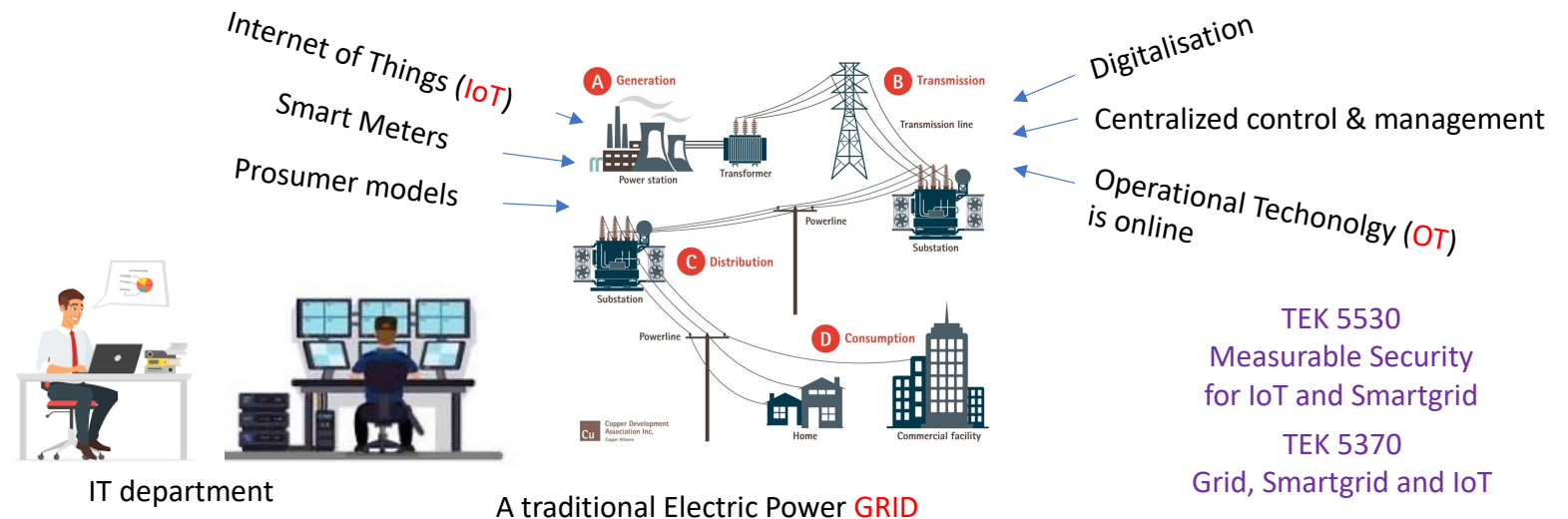
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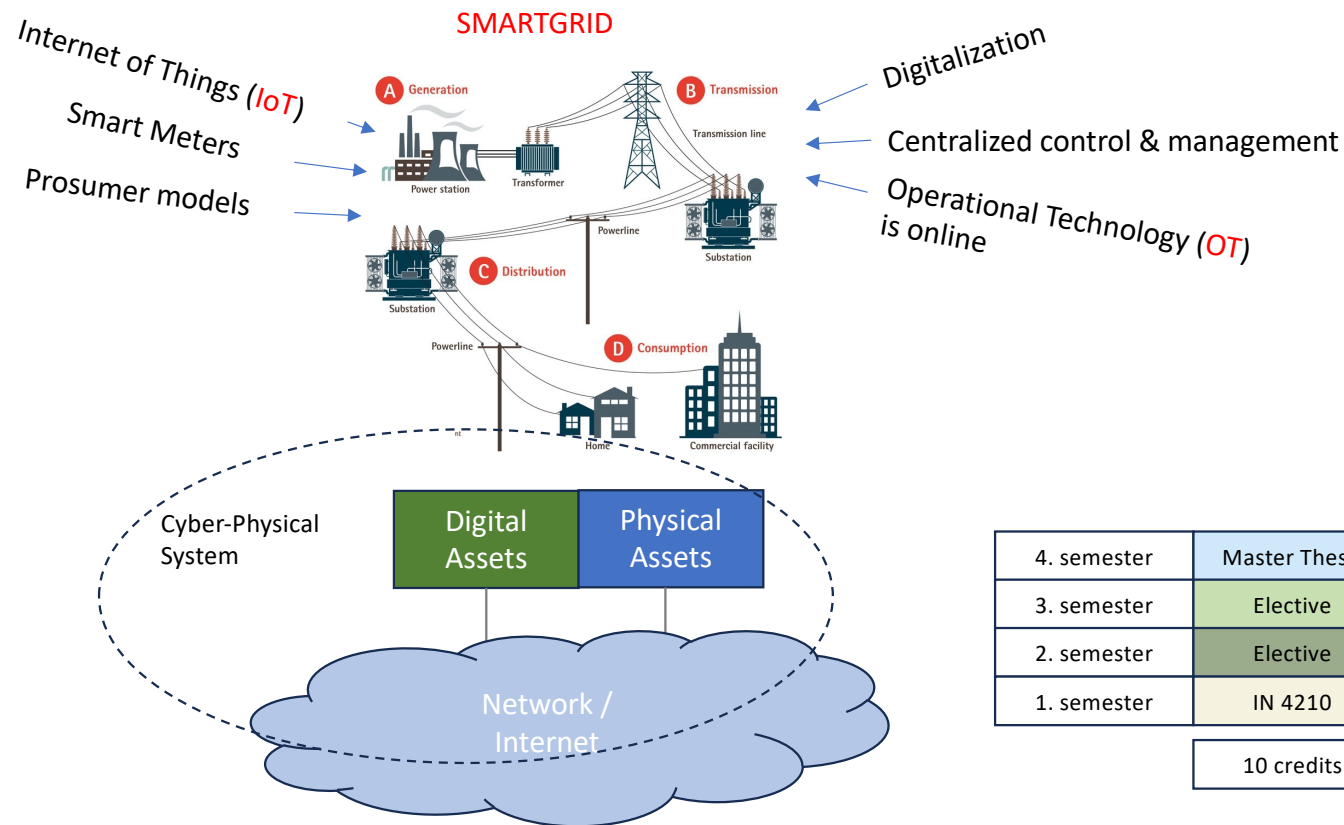


	"Physical"		
4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	Elective	Elective	TEK 5570
2. semester	Elective	TEK 5530	TEK 4560
1. semester	IN 4210	TEK 5370	TEK 4000
	10 credits	10 credits	10 credits

What is Cyber Physical systems, anyway?

- Digital Assets and Physical Assets are gradually merging, i.e. physical assets gets “online”

Example from previous



TEK 5570
Project Course in
Cyber Physical Systems

TEK 4560
Basic Security in
Cyber Physical Systems

“Cyber Physical”

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3. semester	Elective	Elective	TEK 5570
2. semester	Elective	TEK 5530 Elec- tive	TEK 4560
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Integration of IT-OT (digitalization) -> Cyber-Physical Systems

This creates a lot of new threats

- Threat actors are increasingly targeting OT environments
 - Malware and methods are being adapted.
 - Example: ransomware targeting OT increased 87% from 2021 to 2022
- OT networks are used to control everything from
 - industrial production
 - transportation
 - water treatment
 - oil and gas
 - power plants
 - power grids
 - all critical infrastructure
- All are complex systems

TEK 4000
Systems Engineering

“Systems”

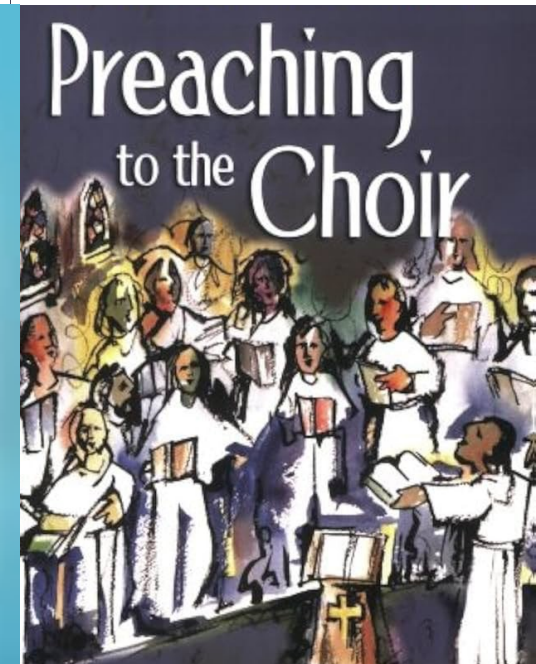
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Source: https://www.telenor.no/binaries/om/digital-sikkerhet/2023/Digital_sikkerhet_2023.pdf

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Why “Security in Cyber-Physical Systems”?



Physical Systems are everywhere

Our home environment

Critical infrastructures

Operational Technology (OT)



Agriculture



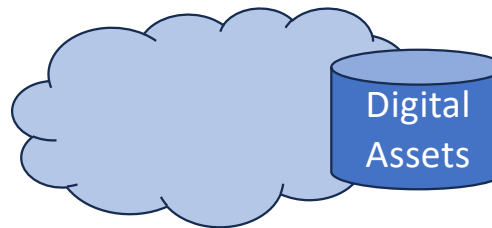
Industrial production



Electric grid



Buildings



Energy production



Homes



Vehicles



Transport systems

Assets have always needed to be secured

Our home environment

Critical infrastructures

Operational Technology (OT)



Agriculture



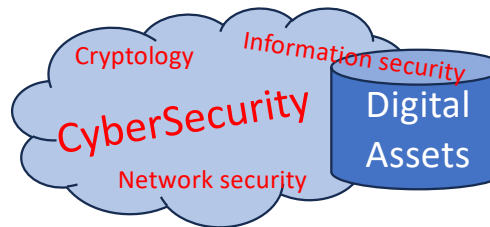
Industrial production



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Energy production



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Transport systems

The digitalization leads to cyber-physical systems



Agricultural robotics



Industrial



Smart grid



Building automation



Smart Homes



Autonomous Vehicles

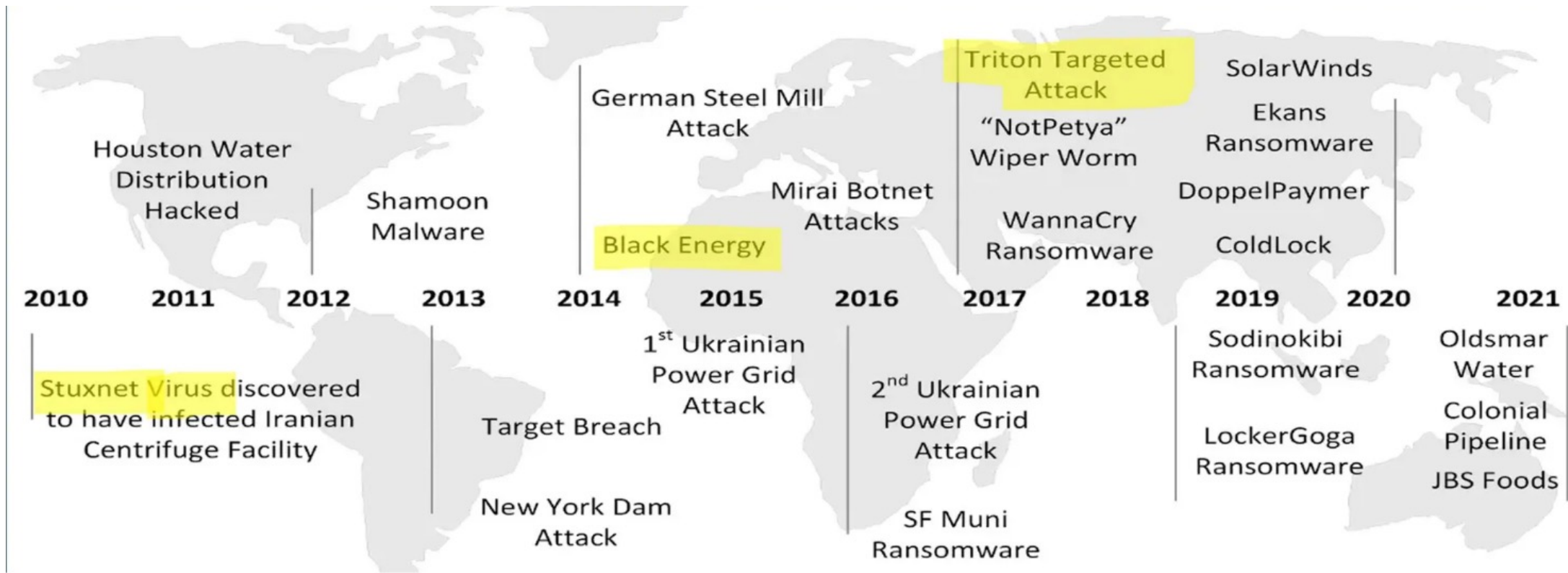


Unmanned oil rigs



Intelligent Transport systems

A sub-field of security that is getting more and more relevant



A sub-field of security more
and more relevant



Some people focus on the communication and the distributed nature of the systems



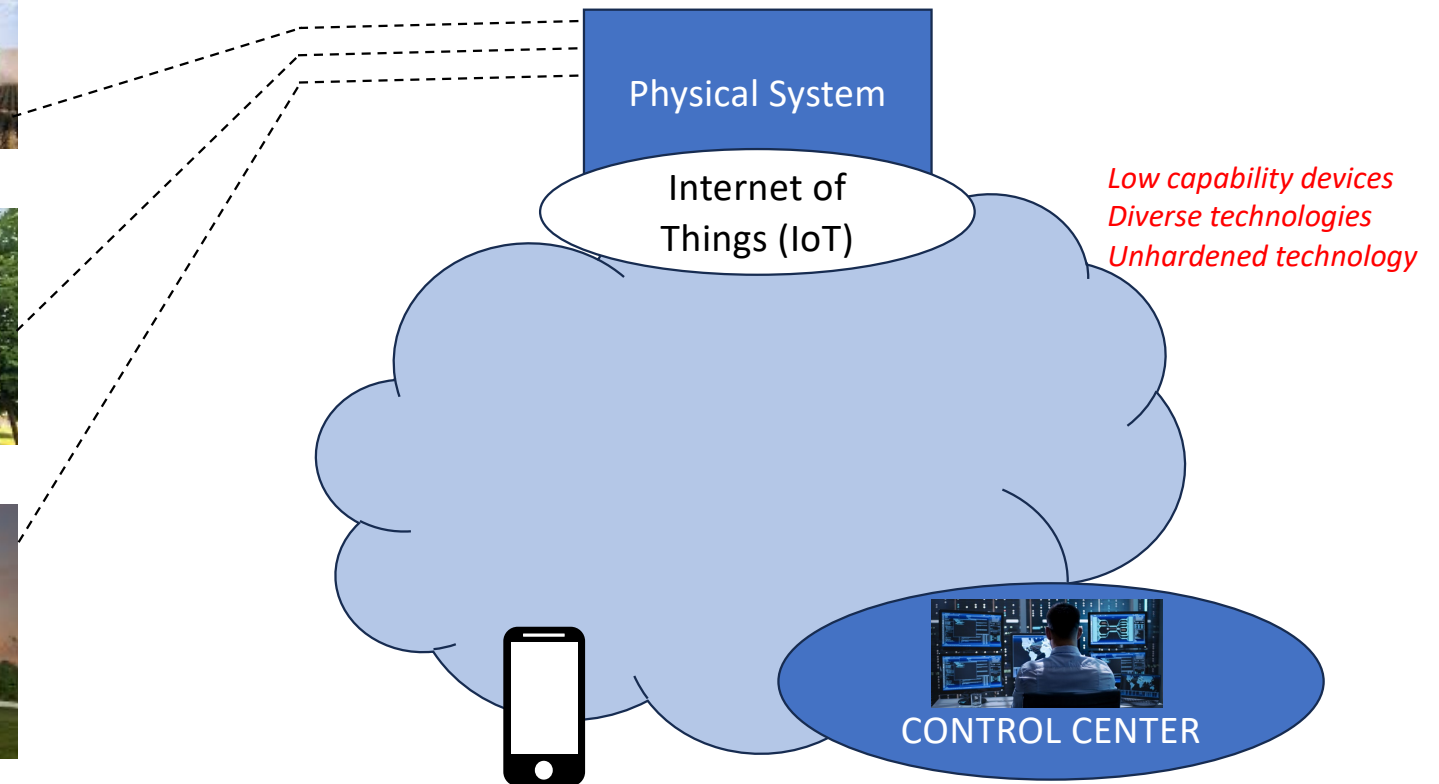
Agricultural robotics



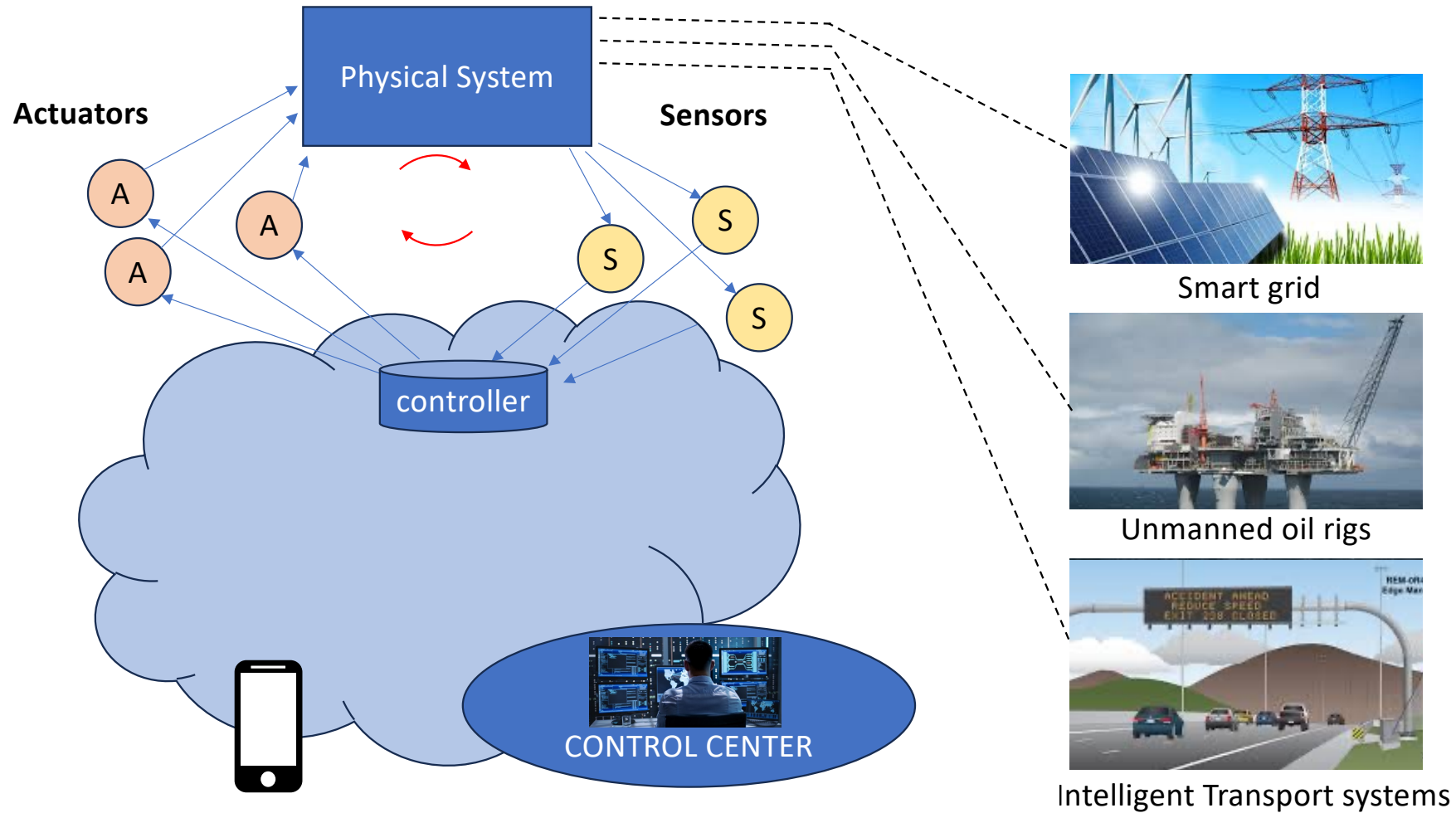
Building automation



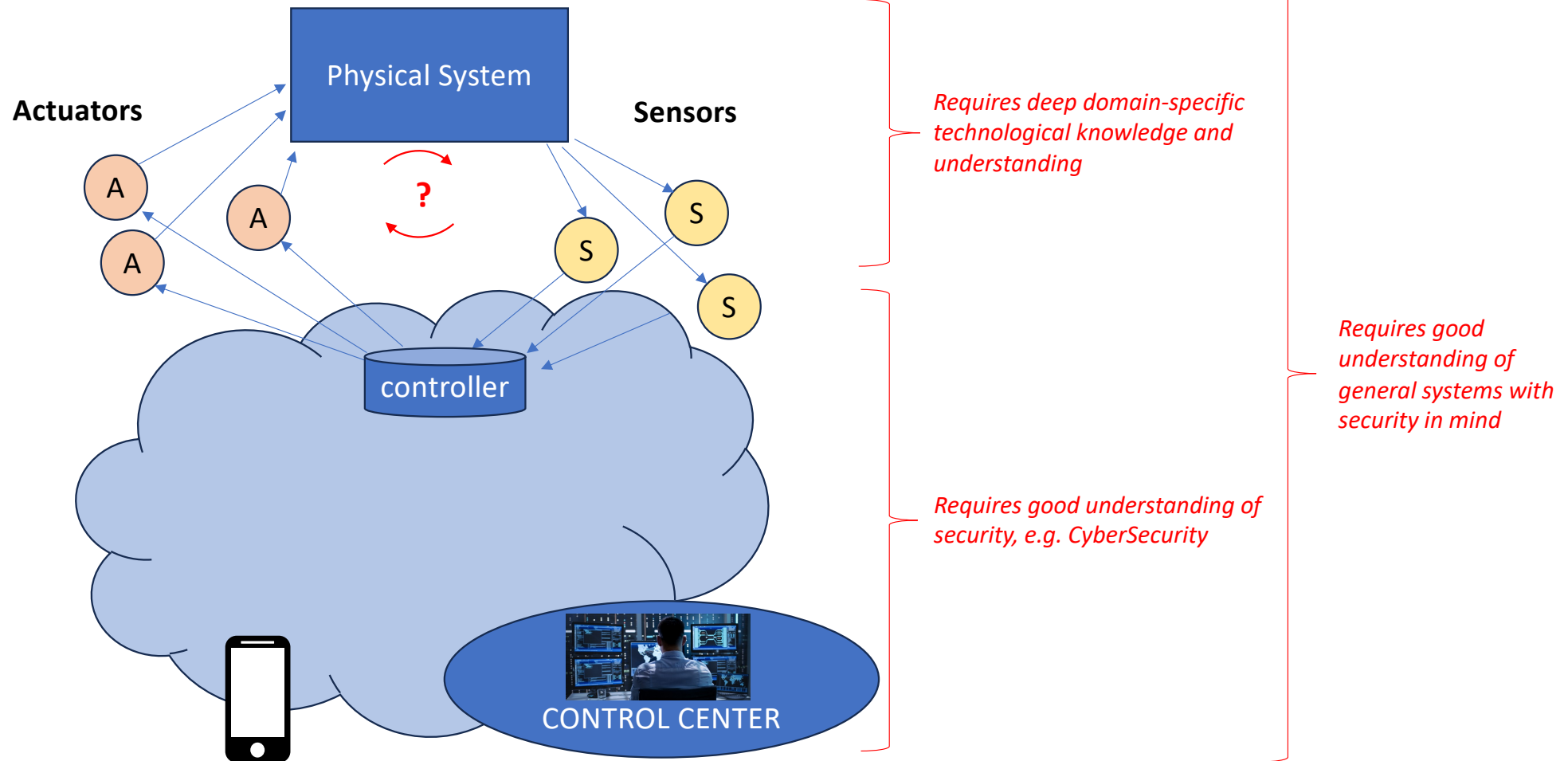
Smart Homes



Others focus more on the control of the systems



Inherently challenging to secure



Traditional security world



Everyone understands that this requires Information security measures

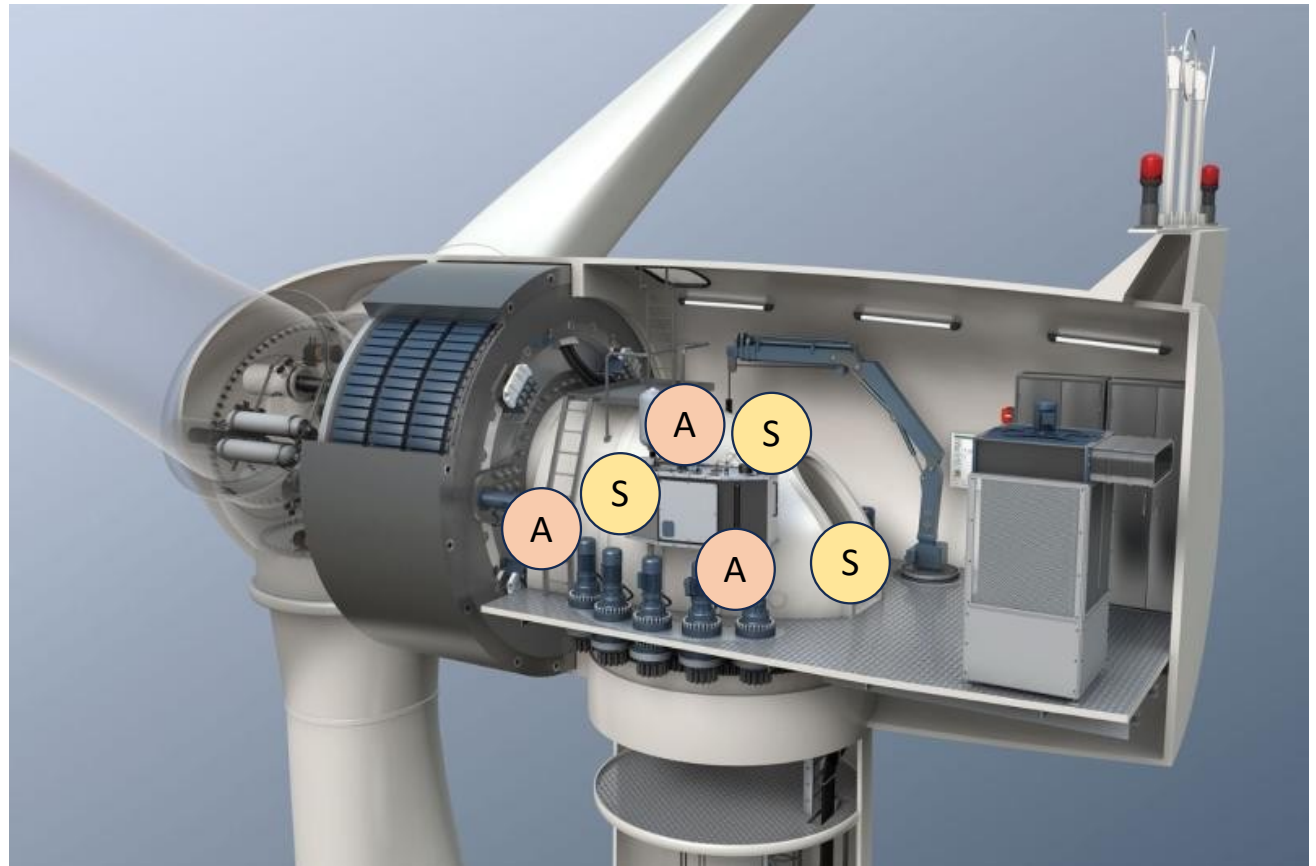
Operational world



This is more challenging to understand

- “Cyber”: General **security** knowledge
- “Physical”: Specific technology domain knowledge
- “System”: General understanding

The physical part of the Cyber-Physical system makes it unique and hard to secure



The new Master's program option at ITS addresses this

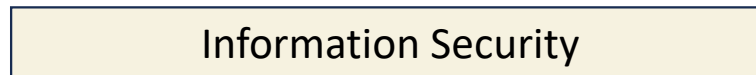
	"Cyber"	"Physical"	"Systems"
4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	Elective (Fall)	Elective (Fall)	Security in Cyber-Phy. Sys.: PROJECT
2. semester	Elective (Spring)	Sec. SmartGrid & IoT	Security in Cyber-Physical Systems
1. semester	Network security	Grid, Smartgrid and IoT	Systems Engineering
	10 credits	10 credits	10 credits

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The Master's Programme Structure

One common "Master's Programme" :



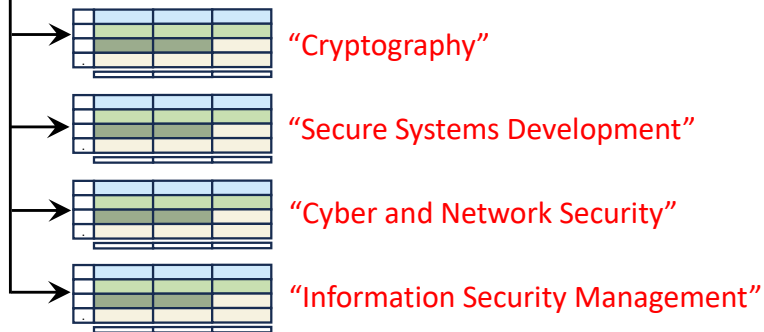
... is divided into...

...two "Programme Options" (studieretninger) :

4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	Master Course	Master Course	Master Course
2. semester	Master Course	Master Course	Master Course
1. semester	Master Course	Master Course	Master Course
		10 credits	10 credits

"Information security"
programme option by Dept of Informatics - IFI

...contains four "Specializations":



4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	Elective	Elective	TEK 5570
2. semester	Elective	TEK 5530	Elective TEK 4560
1. semester	IN 4210	TEK 5370	Elective TEK 4000
		10 credits	10 credits

"Security in Cyber-Physical Systems"
programme option by Dept of Technology Systems - ITS

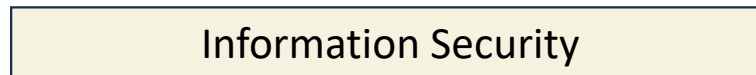
No "Specializations"



You are here!

Positive synergies within the Master's Programme Structure

One common "Master's Programme" :



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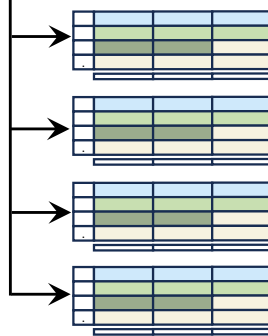
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"Security in Cyber-Physical Systems"
programme option by Dept of Technology Systems - ITS

...contains four "Specializations":



"Cryptography"

"Secure Systems Development"

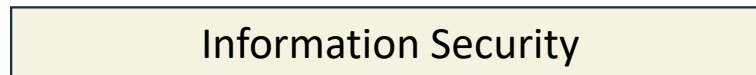
"Cyber and Network Security"

"Information Security Management"

Network security	Security in OS and software	Intro cryptography	Advanced Cryptology
Network security	Security in OS and software	privacy by design	Agile Software engineering
Network security	Security in OS and software	Ethical Hacking	Cyber Operations
Privacy by design	Unassailable IT systems	Security and Risk Management	IT and Management

Positive synergies within the Master's Programme Structure

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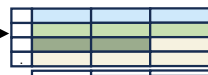
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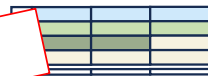
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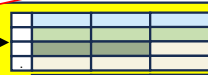
"Cryptography"

Network security	Security in OS and software	Intro cryptography	Advanced Cryptology
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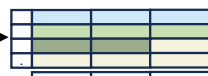
"Secure Systems Development"

Network security	Security in OS and software	privacy by design	Agile Software engineering
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"Cyber and Network Security"

Network security	Security in OS and software	Ethical Hacking	Cyber Operations
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"Information Security Management"

Privacy by design	Unassailable IT systems	Security and Risk Management	IT and Management
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EXAMPLE

A very typical choice of elective courses among students

4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	Security in OS and software	CyberSecurity in Industrial Systems	Security in Cyber-Phy. Sys.: PROJECT
2. semester	Cyber Operations	Sec. SmartGrid & IoT	Security in Cyber-Physical Systems
1. semester	Network security	Ethical Hacking	Systems Engineering
	10 credits	10 credits	10 credits

“Cyber Security”

“Security in CyberPhysical Systems”

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You must choose: “Short” or “long” master

- Main default option: “Short master”, i.e. Master Thesis of 30 credits:

4. semester	Master Thesis	Master Thesis		Master Thesis
3. semester	Elective (Fall)	Elective (Fall)		TEK 5570
2. semester	Elective (Spring)	TEK 5530	Elective	TEK 4560
1. semester	IN 4210	TEK 5370	Elective	TEK 4000
10 credits		10 credits		10 credits

A short master variant is recommended for most students.

You can postpone this decision until 1. Dec.

“Long master” (Master thesis of 60 credits)

4. semester	Master Thesis	Master Thesis		Master Thesis
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Not discussed more in this presentation

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You must choose: “Power-grid” focus or “general” focus

- You choose either TEK5370 or TEK5330 as your mandatory course

4. semester	Master Thesis	Master Thesis	Master Thesis
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2. semester	Elective (Spring)	TEK 5530	Elective
1. semester	IN 4210	TEK 5370	Elective
10 credits		10 credits	10 credits

General focus:

“Measurable Security for IoT and SmartGrid”

Power-grid focus:

“Grid, Smartgrid and IoT”

Teacher of both courses:



**Josef Noll
(Prof.)**

*If you go for general focus,
you need to find elective
course for this fall – ASAP*

You must choose: “Power-grid” focus or “general” focus

- Default option: **Power-grid focus**

4. semester	Master Thesis	Master Thesis	Master Thesis
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~~General focus:~~
 “Measurement Security for IoT and SmartGrid”

Power-grid focus:
 “Grid, Smartgrid and IoT”

Alternative option: General focus

4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	Elective	Elective	TEK 5570
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You must choose: “Power-grid” focus or “general” focus

- Alternative option: **General focus**

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General focus:
“Measurable Security for IoT and SmartGrid”

Power-grid focus:
“Grid, SmartGrid and IoT”

*If you go for general focus,
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Default option: Power-grid focus

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3. semester	Elective	Elective	TEK 5570
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You must choose: “Power-grid” focus or “general” focus

- Alternative option: **General focus**

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General focus:
“Measurable Security for IoT and SmartGrid”

Power-grid focus:
“Grid, SmartGrid and IoT”

- Requires the following actions by you:
 - Sign up for an extra elective course for this autumn
 - An “IN XXXX” course: **Deadline 14 August (tomorrow!)**
 - F.ex.: “IN5290 Ethical Hacking”
 - A “TEK XXXX” course: Deadline: ASAP before **1. Sept.**
 - F.ex.: “TEK 5510 Security in Operating Systems and Software” or “TEK 4500 Introduction to Cryptography”
 - After having been admitted, apply to ITS study admin (e.g. Kaja) for the course change
 - If accepted application withdraw from the default “TEK 5370” course (otherwise withdraw from the elected)

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TEK5530: Measurable Security for the Internet of Things and Smart Grids (spring)

- Become the security expert for critical infrastructures
- “measure” and assess security



Six Pillars of a Zero Trust Security Model

UNIVERSITY OF OSLO

Contact:
Prof. Josef Noll,
Technology Systems (ITS),
m: +47 9083 8066



TEK5370: Grid, Smart Grid og IoT (autumn)

- Become a domain expert in Smart Grid & IoT
- Address security challenges from a risk analysis

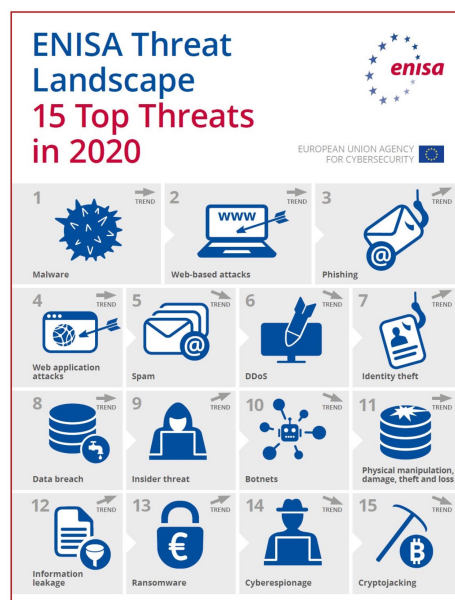


Your choice: “domain” or “security” expert - or both select TEK5530 or TEK5370 as obligatory course

Measurable Security (TEK5530)

Threat landscape
zero trust
Risk management
NSM principles for
ICT-security

visit companies
group work:
security assessment



Grid, Smart Grid & IoT (TEK5370)

Grid: transformers, conversion AC-DC,
transmission lines

Smart Grid: Infrastructure for Renewable
Energy

Secure and trusted IoT interaction

visit Nordic Booster
group work:
home control

400Amp
Opp til 920 VDC



Just to repeat...

- Alternative option: **General focus**

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"Measurable Security for IoT and SmartGrid"

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"Grid, SmartGrid and IoT"

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SCP: Master Program – Recommended courses

*Mix as you wish, but you need 1-2 **SPRING** and 2-3 **FALL** courses:*

TEK5520 – Cyber Security of Industrial Systems (FALL)

IN5540 – Cyber Operations (SPRING)

IN5290 – Ethical Hacking (FALL)

TEK5510 – Security in Operating Systems and Software (FALL)

IN5540 – Privacy by Design (FALL)

IN5080 – Security and Risk Management (SPRING)

TEK4500 – Introduction to Cryptography (FALL)

TEK5550 – Advanced topics in Cryptology (SPRING)

TEK5530 – Measurable Security for the Internet of Things (SPRING)

TEK5300 – Renewable Energy: Science and Technology (FALL)

You might choose other courses, as well.

Specializations in other programme option might inspire

4. semester	Cryptography			Masteroppgave
3. semester	Masteroppgave	Masteroppgave	Masteremne	
2. semester	Masteroppgave	Masteremne	TEK5550 – Avanserte områder innen kryptologi	
1. semester	TEK4500 – Innføring i kryptografi	IN4210 – Network and Communications Security	TEK5510 – Sikkerhet i operativsystemer og programvare	
	10 studiepoeng	10 studiepoeng	10 studiepoeng	

4. semester	Cyber and Network Security			Masteroppgave
3. semester	Masteroppgave	Masteroppgave	Masteremne	
2. semester	Masteroppgave	Masteremne	IN4180 – Cyber Operations	
1. semester	IN4210 – Network and Communications Security	TEK5510 – Sikkerhet i operativsystemer og programvare	IN5290 – Ethical Hacking	
	10 studiepoeng	10 studiepoeng	10 studiepoeng	

4. semester	Information Security Management			Masteroppgave
3. semester	Masteroppgave	Masteroppgave	Masteremne	
2. semester	Masteroppgave	IN5080 – Sikkerhets- og risikostyring	IN5431 – IT and Management/ IN5430	
1. semester	Masteremne	IN5130 – Uangripelige IT-systemer	IN5540 – Privacy by Design	
	10 studiepoeng	10 studiepoeng	10 studiepoeng	

4. semester	Secure Systems Development			Masteroppgave
3. semester	Masteroppgave	Masteroppgave	IN5140 – Smarte prosesser og smidige metoder i systemutvikling	
2. semester	Masteroppgave	Masteremne	Masteremne	
1. semester	IN5290 – Ethical Hacking	IN5540 – Privacy by Design	TEK5510 – Sikkerhet i operativsystemer og programvare	
	10 studiepoeng	10 studiepoeng	10 studiepoeng	

Full Master Program Plan (Due 1. Dec.) – Example 1

- IDEA:

Hands-on Cyber Security

Domain Knowledge

System perspective

	Hands-on Cyber Security	Domain Knowledge	System perspective
4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	IN 5290 Ethical Hacking	TEK 5520 Cyber Security of Industrial Systems	TEK 5570 Project Course in Cyber Physical Systems
2. semester	IN 5540 Cyber Operations	TEK 5530 Measurable Security for IoT and Smartgrid	TEK 4560 Basic Security in Cyber Physical Systems
1. semester	IN 4210 Network and Comm. Security	TEK 5370 Grid, Smartgrid and IoT	TEK 4000 Systems Engineering
	10 credits	10 credits	10 credits

Full Master Program Plan (Due 1. Dec.) – Example 2a



- IDEA: A specialization towards “Cyber and Network Security” (★)

4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	TEK 5510 Security in Operating Systems and Software ★	TEK 5520 Cyber Security of Industrial Systems	TEK 5570 Project Course in Cyber Physical Systems
2. semester	IN 5540 Cyber Operations ★	TEK 5530 Measurable Security for IoT and Smartgrid	TEK 4560 Basic Security in Cyber Physical Systems
1. semester	IN 4210 Network and Comm. Security ★	IN 5290 Ethical Hacking ★	TEK 4000 Systems Engineering
	10 credits	10 credits	10 credits

Deadline: 14. August

Full Master Program Plan (Due 1. Dec.) – Example 2b

- IDEA: A specialization towards “Cyber and Network Security” (★)

4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	IN 5290 Ethical Hacking ★	TEK 5520 Cyber Security of Industrial Systems	TEK 5570 Project Course in Cyber Physical Systems
2. semester	IN 5540 Cyber Operations ★	TEK 5530 Measurable Security for IoT and Smartgrid	TEK 4560 Basic Security in Cyber Physical Systems
1. semester	IN 4210 Network and Comm. Security ★	TEK 5510 Security in Operating Systems and Software ★	TEK 4000 Systems Engineering
	10 credits	10 credits	10 credits

Deadline: 1. September

Full Master Program Plan (Due 1. Dec.) – Example 3

- IDEA: A specialization towards “Management of Information Security” (★)

4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	IN 5540 Privacy by Design ★	IN5130 Unassailable IT-systems ★	TEK 5570 Project Course in Cyber Physical Systems
2. semester	IN 5080 Security and Risk Management ★	TEK 5530 Measurable Security for IoT and Smartgrid	TEK 4560 Basic Security in Cyber Physical Systems
1. semester	IN 4210 Network and Comm. Security	TEK 5370 Grid, Smartgrid and IoT	TEK 4000 Systems Engineering
	10 credits	10 credits	10 credits

Full Master Program Plan (Due 1. Dec.) – Example 4

- IDEA: A specialization towards “Cryptograpy” (★)

4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	TEK 5510 Security in Operating Systems and Software	TEK5110 Building and Monitoring Communication Networks	TEK 5570 Project Course in Cyber Physical Systems
2. semester	TEK5550 Advanced topics in Cryptology ★	TEK 5530 Measurable Security for IoT and Smartgrid	TEK 4560 Basic Security in Cyber Physical Systems
1. semester	IN 4210 Network and Comm. Security	TEK 4500 Introduction to Cryptography ★	TEK 4000 Systems Engineering
	10 credits	10 credits	10 credits

Deadline: 1. September

Full Master Program Plan (Due 1. Dec.) – Example 5

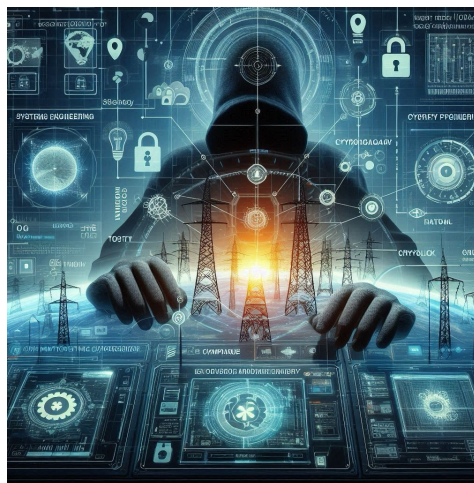
- IDEA: Mix randomly according to your own curiosity and interests

4. semester	Master Thesis	Master Thesis	Master Thesis
3. semester	TEK 4500 Introduction to Cryptography	TEK5300 Renewable Energy: Science and Technology	TEK 5570 Project Course in Cyber Physical Systems
2. semester	IN 5430/5431 IT and Managment	TEK 5530 Measurable Security for IoT and Smartgrid	TEK 4560 Basic Security in Cyber Physical Systems
1. semester	IN 4210 Network and Comm. Security	TEK 5370 Grid, Smartgrid and IoT	TEK 4000 Systems Engineering
	10 credits	10 credits	10 credits

Also start planning for your Master Thesis (Deadline 1 Dec)

- Master thesis – 30 credits (or 60)
 - Independent “research-like” work under supervision
- Find a preliminary supervisor within 1. December
 - Together with a complete preliminary plan for your study
 - Discuss a preliminary topic with your supervisor
- Master thesis at ITS
 - Discuss with lecturers in the time ahead
 - Presentation of Master thesis topics at ITS, probably end of October
 - Preliminary supervisor could also be Georgios Kavallieratos
- Master thesis at IFI – within information security
 - <https://www.mn.uio.no/ifi/studier/masteroppgaver/informasjonssikkerhet/>
 - (If you need a proforma supervisor at ITS, e.g. Paal Engelstad)
- Master thesis in a company
 - Then, you must find an external supervisor in the company, and then you will get an internal supervisor at ITS, e.g. Paal Engelstad

Welcome to this Master Program in Security in CyberPhysical Systems!



Questions?