UNIVERSITY OF OSLO

TEK5110: L1 Introduction

Building and Controlling Communication Networks using IoT-devices

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Catalysts for the SDGs?

Role of Internet?

Business model?

The Internet failed



From Academia to Mobile Broadband
understanding the business

Jun1973: NO (Kjeller) & GB connected

Jun1986: RARE/TERENA…GEANT (NRENs in Europe)



1993 - **privatisation** of 2G (GSM)

1999 - 3G (UMTS): 3 x ROI expectation, Uni co-dev

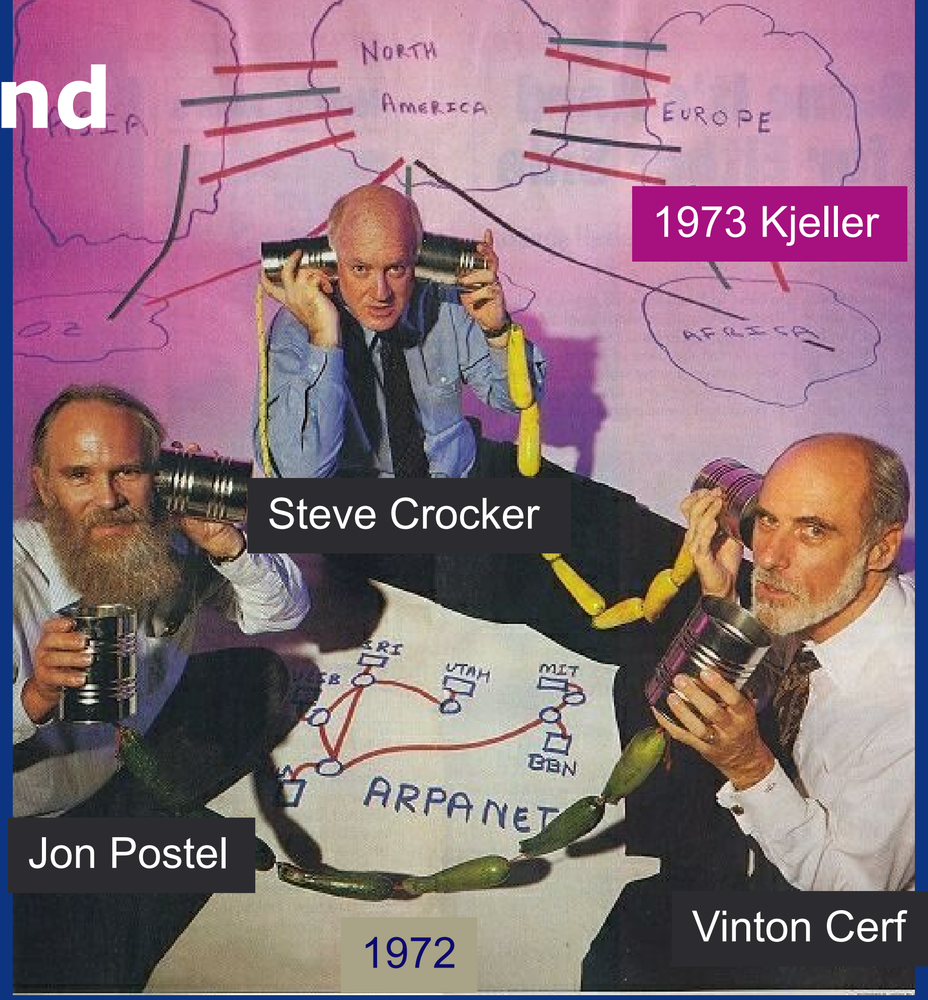
2004 - 4G (LTE): 120 km range, Supplier dev

Aug2003: Reykjavik “Cybersecurity"

Mar2023: “Societal Security” - Digital Equity - #ConnectTheFuture



Vint & Sigrid, Nordunet 2003



Source: http://www.michaelkaul.de/History/history.htm

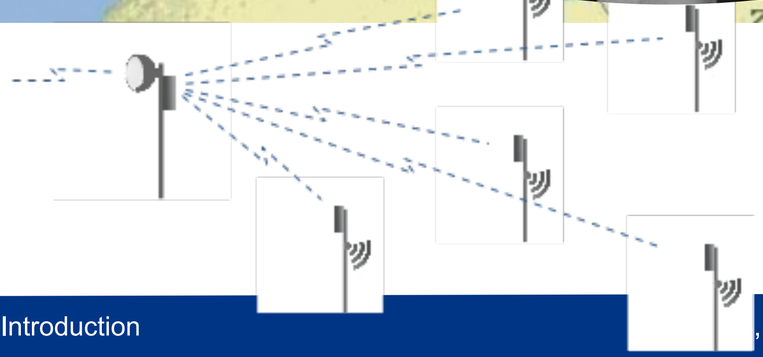
“The mobile Internet is purely commercial”

Background/Challenges

- Internet provision to various parts of DRC
  - operations since 2011
- Connection to a.o. University of Lisala
- Experiences from Internet provision
  - Expensive access: 2000 US$/month for 1 Mbit/s
    Note: 80 Mbit/s for 66 US$ (NO), factor: 2.420 or 0.04%
  - Requirement for self-sustainable infrastructure

- Developed network infrastructure
  - low-cost establishment of local hot-spots
  - remote core infrastructure (in Norway)
  - based on experiences from Internet history at UiO/UNIK





Business model?

How to "Connect the Future" and "Empower my Dreams"

- Western World
  - fixed & mobile & work - about 100-200 USD/family
  - 17.000 base stations, EU: 421.000 towers [Statista]
- Example: Tanzania
  - large distances (3 x s of Norway)
    - expensive access
    - negligible fixed broadband
  - ability to pay: 10-20 USD/family
- Europe vs Africa
  - 6.8% vs 20% of land area
  - 746 million vs 1.3 billion (2018)
  - 112 vs 43 people/km² [Worldbank, Statista]



https://event.tu.no/filer/insidekonf_v_2019/Eivind_Mikkelsen_Trenger_Norge_100.000_basestasjoner.pdf

Role of the Internet?

World Summit of the Information Society - WSIS 2023



Doreen Bogdan
Secretary General ITU





Catalysts for the SDGs?



SDG 1.4 Equal access to basic services

SDG 4.A Education facilities for effective learning for all

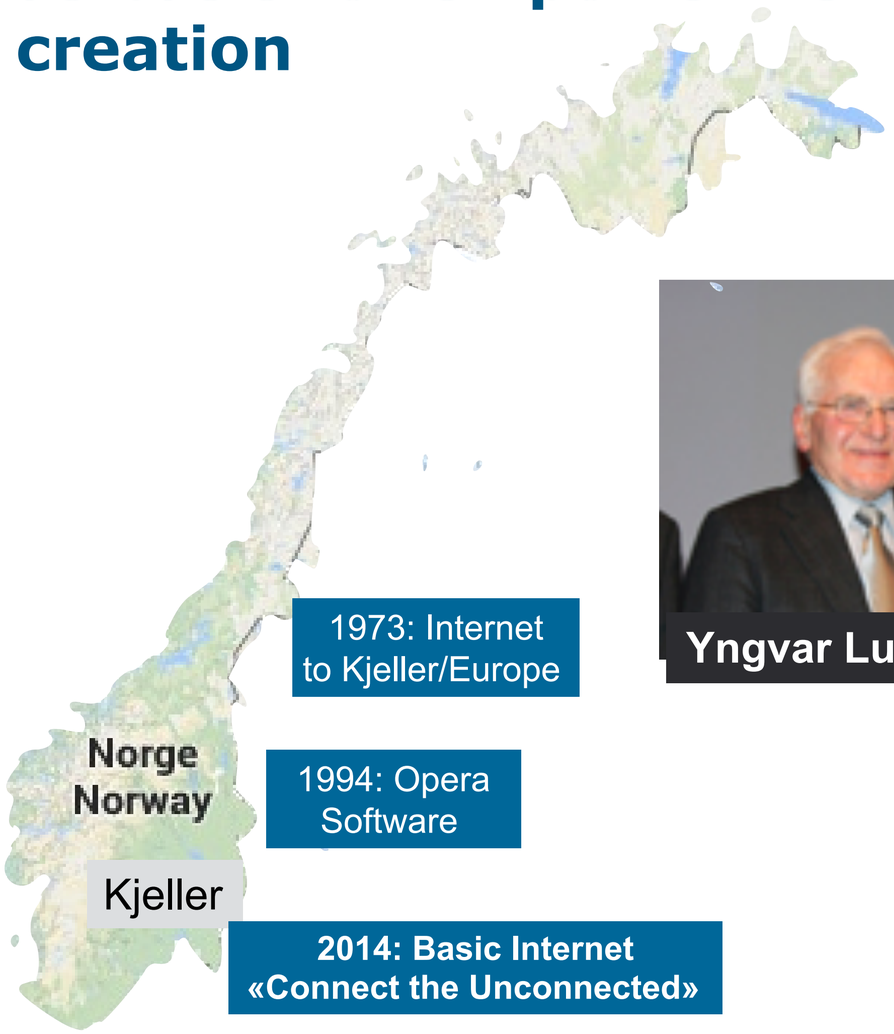
SDG 5.B Use of enabling technologies

SDG 9.C universal and affordable access

SDG 16.10 ensure public access to information

SDG 17 Partnerships for the Goals

An inclusive Next Generation Internet as basis for empowerment and value creation

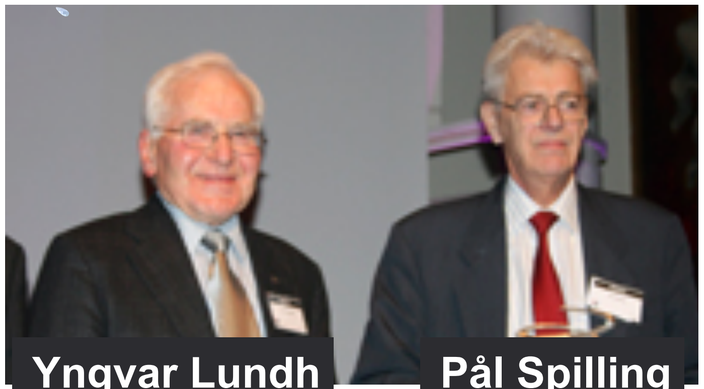


1973: Internet to Kjeller/Europe

1994: Opera Software

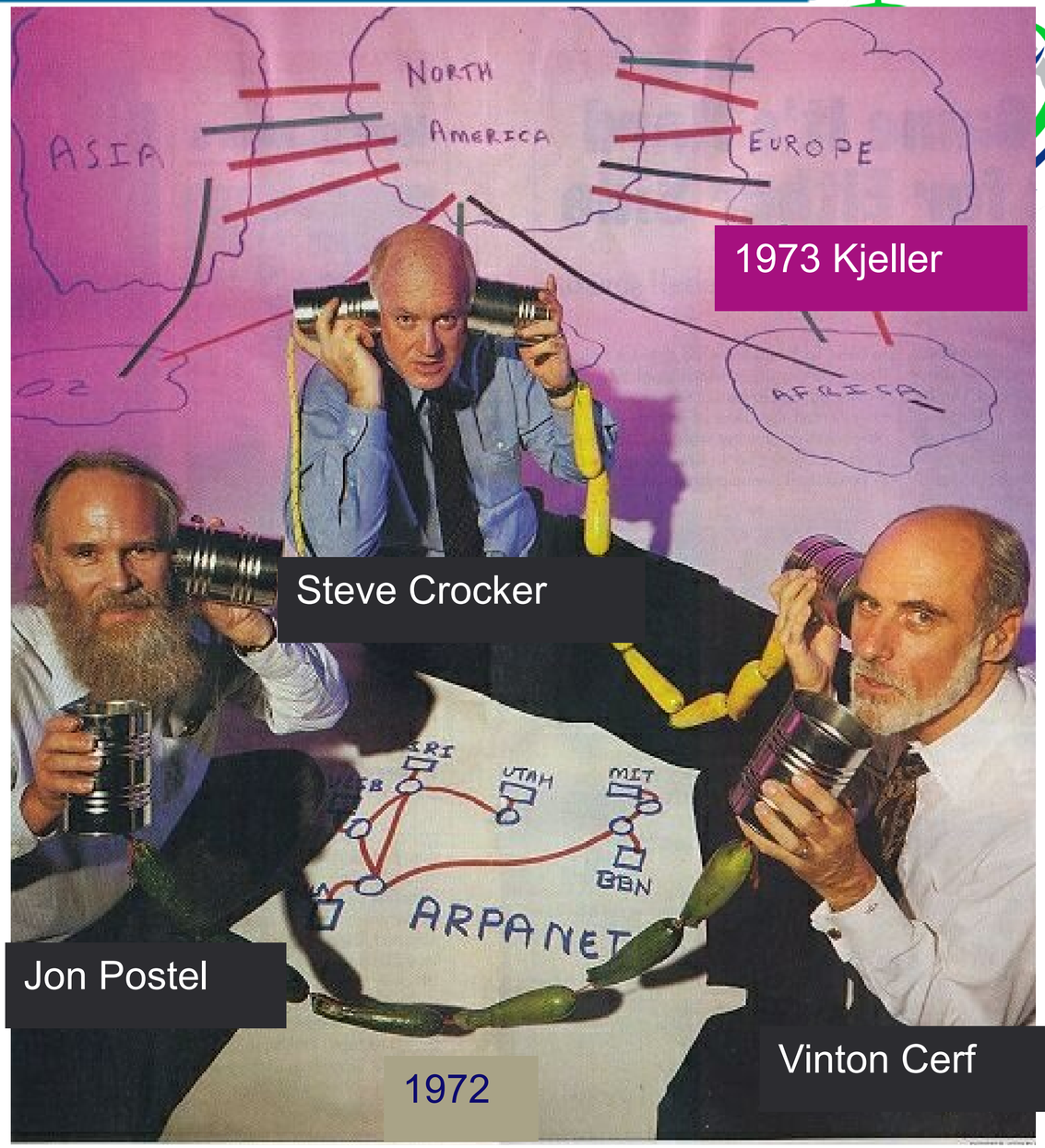
Kjeller

2014: Basic Internet «Connect the Unconnected»



Yngvar Lundh

Pål Spilling



1973 Kjeller

Steve Crocker

Jon Postel

Vinton Cerf

1972

Source: http://www.michaelkaul.de/History/history.html

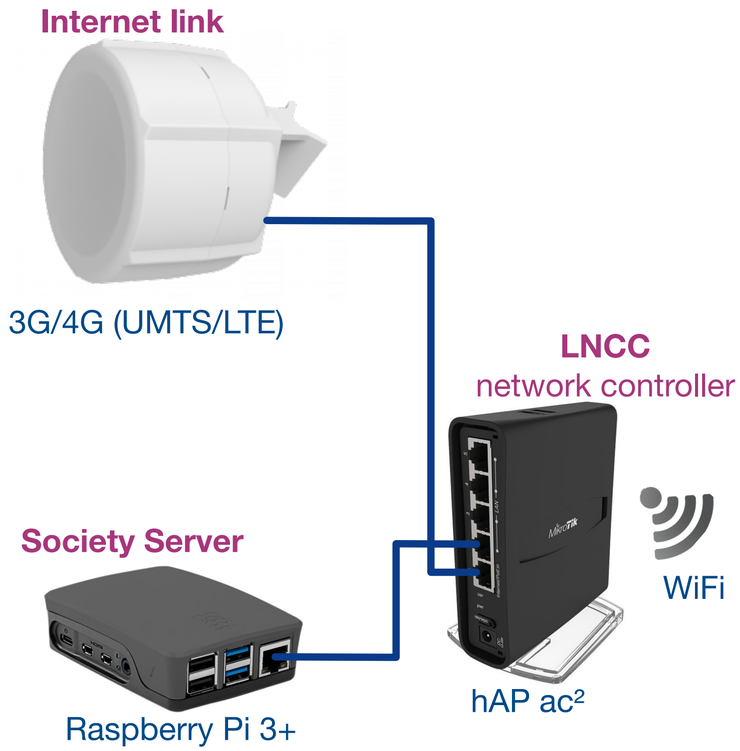
Problems being addressed in TEK5110

- How can we bring access to the Internet to every part of the world? (antenna, range, frequency,
- How can we ensure that everyone has free access to the information? (Internet Lite, Raspberry Lite)
- What is the right network for the application I'm looking for
  - - sensors
  - - home broadband
  - - rural areas
- How can we control and troubleshoot communication networks? (what do we need to know?, autoconfig LNCC, scripts)
- How can we monitor and control electricity systems (households: Schneider)



Solving the Access

- wireless information spot (InfoSpot)
- Reaching out >20 km to mobile network
- Affordable solution: OPEX <20 USD/ month





TEK5110 Topics

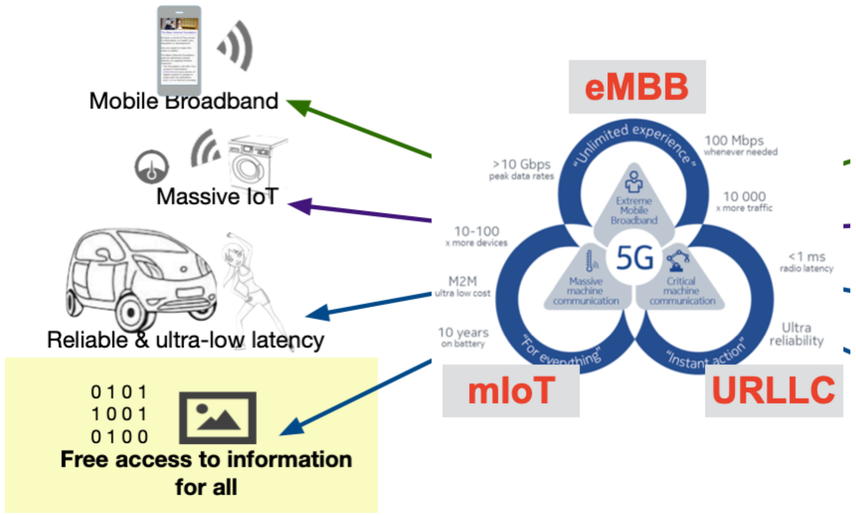
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Topics you will touch into

- 1. **Mobile coverage, capacity and cost** aspects of future mobile and wireless networks
  - coverage, costs, capacity
- 2. **Mobile network development,** shortcomings of 5G
- 3. **Internet lite for all**, providing free access to information for everyone. Examples might be the DigI.BasicInternet.no project on Digital health in TZ.
  - Building a future network
- 4. **IoT monitoring of network** and energy
  - Establish monitoring unit for IoT systems
- 5. **Wireless Network management** for future services.
  - monitoring of a real-life wireless installation,
  - network impact of services and applications with respect to wireless characteristics.



TEK5110 - Expectations “Building and Managing Networks”

- What is your background, what do you expect?
  - discuss
  - tell
- Goal of the course,
  - what to achieve
  - how to achieve it
- Examen
  - what to I expect

What to achieve

- Academic work - you will be asked to write a report

  - how we build up list of references
  - modelling approach
  - detailed list of topic (next slide)

Examen 9Dec2023 (tbc)

- Final oral exam
  - Presentation of your part of the report of the Group work
  - Questions to the report
  - General questions to the topic

Oral Exam

- Presentation of your part of the report (8 min)
- Questions to the report (7 min)
- General questions to the topic (10 min)

Comments/Questions?

Lecture Plan 2023

http://tek5110.its-wiki.no

- 20Aug - L1: Introduction
- 27Aug - L2 Radio principles (Maghsoud), antennas, directivity, Multi-MIMO
- 3Sep - L3 Digital Communications, Capacity
- 9Sep - L4 Information distribution .... Internet Lite, communication with LTE antenna (Basic Internet extension)
- 17Sep - L5 Ideas for Group work, case studies and problem areas (Josef & Maghsoud)
- 24Sep - L6 Real-time monitoring (M) - answering Wifi
- 1Oct L7 Network & IoT Management (M)- architecture remote management
- 8Oct - L8 Presentations - present of the papers -based on the group work topic (Intro, State-of-the-art, plans for implementation), typically 2-4 pages
- 15Oct - L9 IoT- Raspberry Pi, Schneider control (M)
- 22Oct - L10 Wireless & Mobile Networks (J)
- 29Oct L11 - Group work (own work on establishing the solution) - (M)
- 5Nov - L12 Wireless troubleshooting (M)
- 12Nov - L13 Hands-on Wireless configuration (M) /Group work (together with L14)
- 19Nov - L14 Group Presentation, see Group work info & evaluation criteria
- 26Nov - L15 Report writing (10-15 pages report on group work, Master Template)

DRAFT

Expectations for your presentation (L8)

- Define what to present
- Present it such that your colleagues can understand
- Facts/Reference-based presentation
  - Intro/Use case
  - State-of-the-art
  - plans for implementation
- (short 2-4 pages report)

Deep dive into topics

Technology topics

- Internet of Things
- Antenna, Radio wave propagation
- Mobile Communications
- Wireless Communications
- Network characteristics

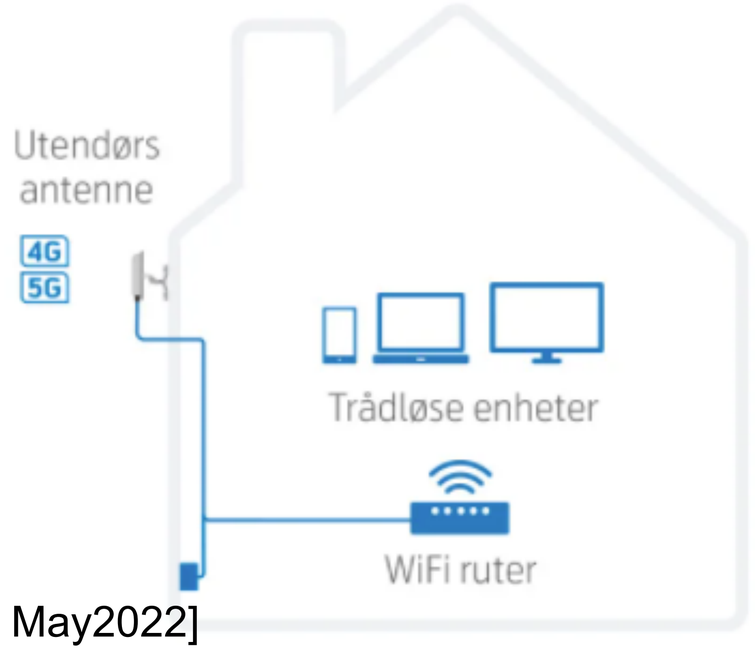
- Monitoring, Controlling, Configuration

Fixed-Wireless Access & autonomous networks

My assumptions for 6G

- 5G/6G as backbone/fiber replacement
  - 10-100 Mbps for 50-70 €/month
  - 100 Gbit/s for fibre extension

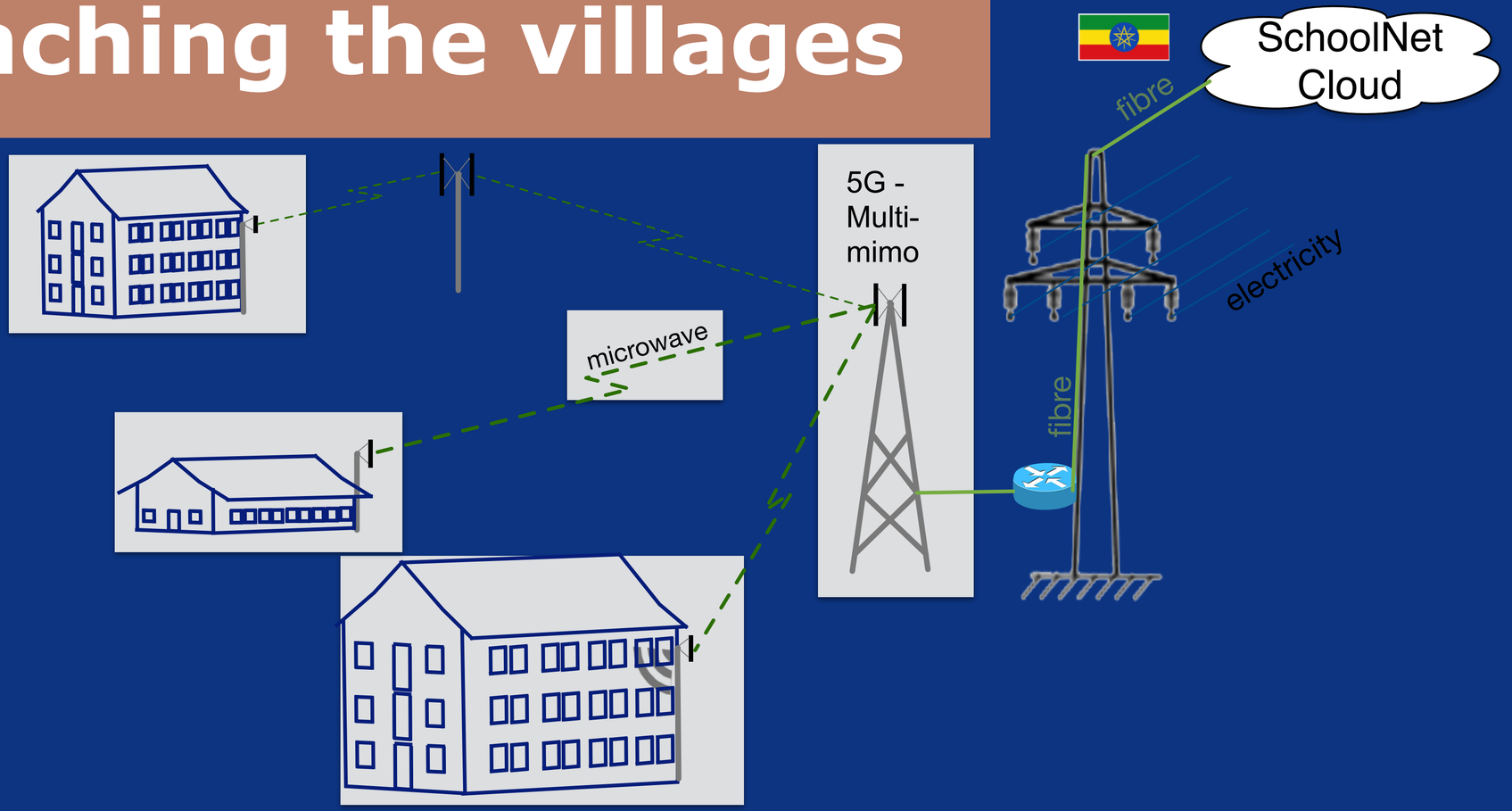




[Source: Telenor.no, May2022]

5G for school connectivity

5G for reaching the villages





- **Research for the (digital) Society**
- **Competence for the Digital Transformation: Access, Skills, Regulations & Inclusion**
- **Connect Schools & unconnected Communities Student involvement and activities**
- **Research based on data from the communities**

Live Transcription (Closed Captioning) has been enabled
Who can see
Talking: Caroline Stratton

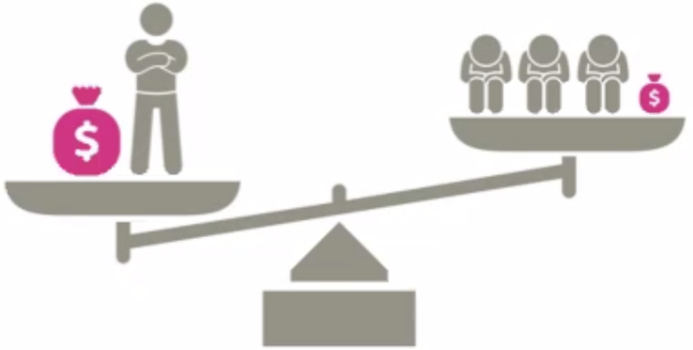
COVID-19 HAS LED TO THE FIRST RISE IN EXTREME POVERTY IN A GENERATION

AN ADDITIONAL **119-124 MILLION PEOPLE** WERE PUSHED BACK INTO **EXTREME POVERTY** IN **2020**



THE PAN

IS LIKELY TO REVERSE PROGRESS
MADE IN REDUCING INCOME INEQUALITY
SINCE THE FINANCIAL CRISIS



COVID-19
ESTIMATED TO INCREASE THE AVERAGE GINI
FOR EMERGING MARKET AND DEVELOPING COUNTRIES
BY 6%

COVID-19
HAS WIPED OUT 20 YEARS OF EDUCATION GAINS

AN ADDITIONAL 101 MILLION OR 9% OF CHILDREN
IN GRADES 1 THROUGH 8 **FELL BELOW**
MINIMUM READING PROFICIENCY LEVELS IN 2020

The Sustainable Development Goals Report
2021

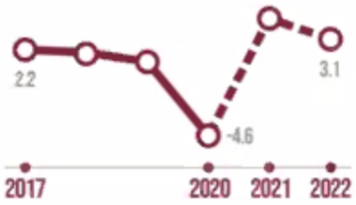
THE PANDEMIC
HAS LED TO THE LOSS OF THE EQUIVALENT OF
255 MILLION FULL-TIME JOBS



ABOUT **4X** THE NUMBER LOST DURING
THE GLOBAL FINANCIAL CRISIS (2007-2009)

ECONOMIC RECOVERY IS UNDER WAY

GLOBAL REAL GDP PER CAPITA
(2017-2022)

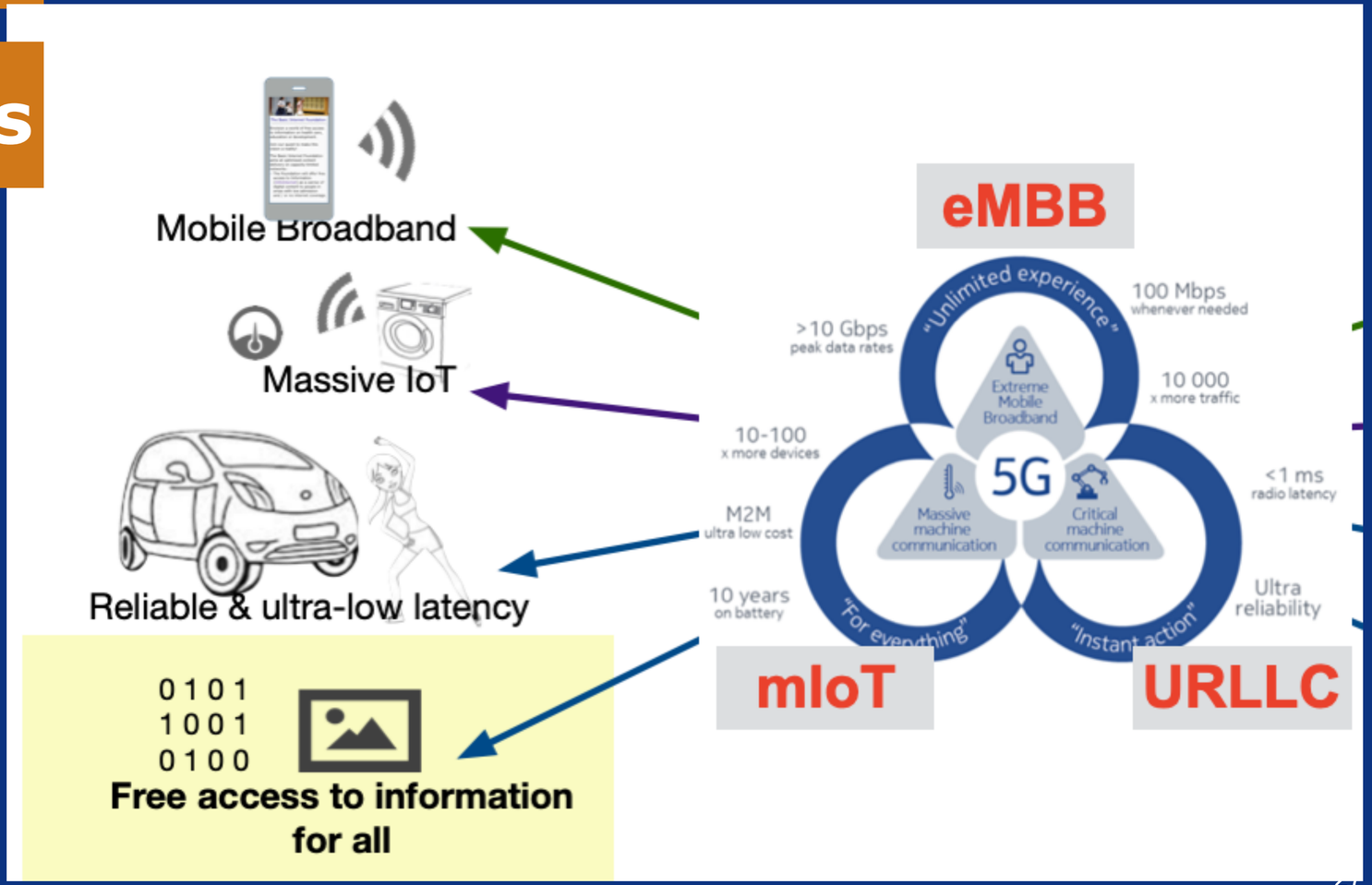


BUT FOR MANY COUNTRIES, ECONOMIC GROWTH IS EXPECTED TO RETURN TO PRE-PANDEMIC LEVELS ONLY IN **2022 OR 2023**

5G network layer

Road model: pedestrians & cyclists

Internet: text & pictures



Internet lite for all

- **How can we ensure that everyone has free access to the information?**
  - Building a future network
  - Filtering “internet lite”
  - network capacity

“Internet lite for all”
adapting the freemium model of the road



Wifi & Sensor Network Management

- **Wireless and Sensor Network management** for future services.
  - monitoring of a real-life wireless installation,
  - network impact of services and applications with respect to wireless characteristics.
  - IoT energy system monitoring
- IoT gateway
  - Raspberry PI installation
  - Cloud integration (edge computing)



Expected areas of the group work

- How can we ensure that everyone has free access to the information? (Internet Lite, Raspberry Lite)
- Networks and applications
  - - sensors
  - - home broadband
  - - rural areas
- How can we control and troubleshoot communication networks? (what do we need to know?, autoconfig LNCC, scripts)
- How can we monitor and **control** electricity systems (households: Schneider)

http://its-wiki.no/wiki/TEK5110/Group_work

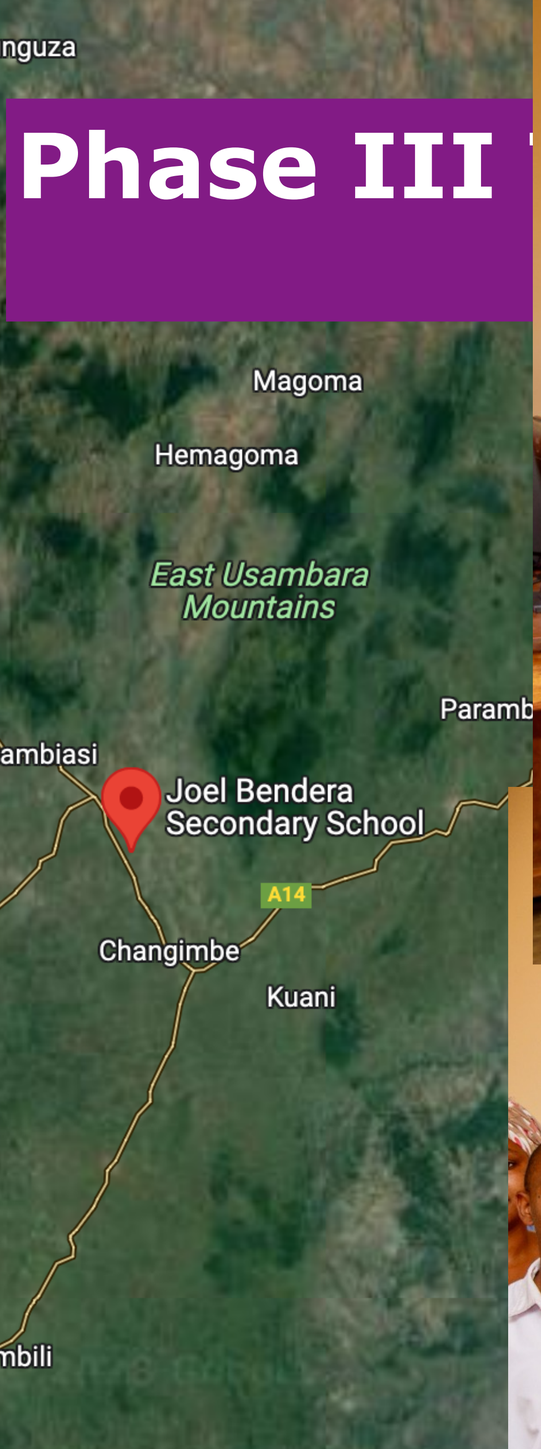
see also:
Evaluation

How can we bring access to the Internet to every part of the world?

- Radio Topics: Antennas, Range, Frequency, Propagation, Capacity

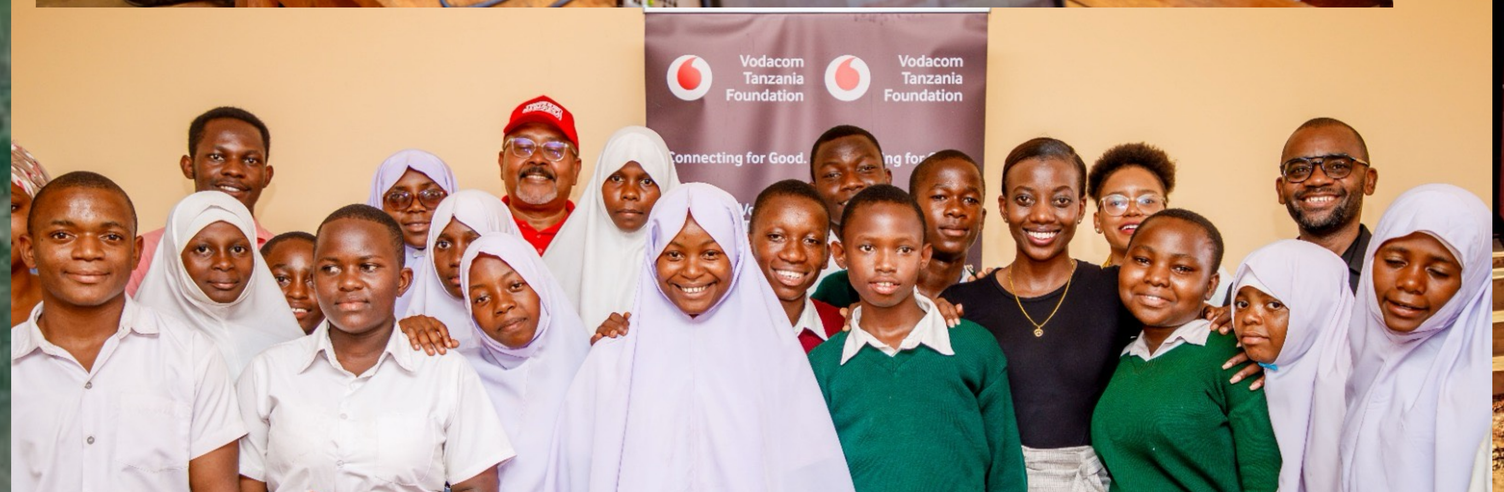
- see: Course by Internet Society on "Building Community Networks" https://www.internetsociety.org/tutorials/wireless-community-networks

Phase III





antenna





Esilalei (2019)
120 W solar panel, light & connectivity





Mbash - primary health station



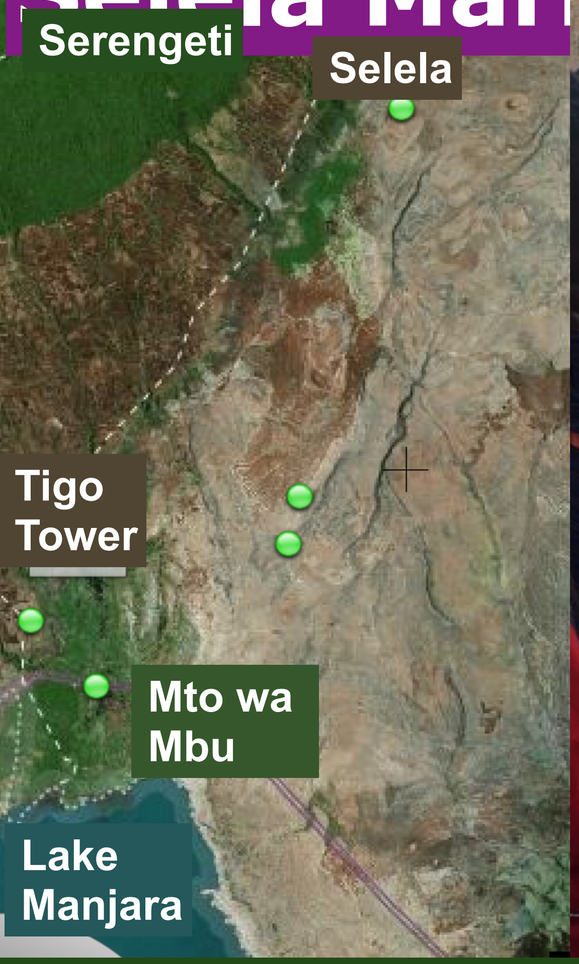




The mobile phone has
replaced the machete
(even in places without Mobile Broadband)

“Connect The Future”

Selela Mar





antenna



- Antenna in 6 m height
- Reaches Tigo tower > 20 km away

“Connect the Future”
Izazi







Installation time: 1,5 h
catching the signal from the Vodacom tower in Migoli (~10km away)

Migoli, Nyerere High School - 2019







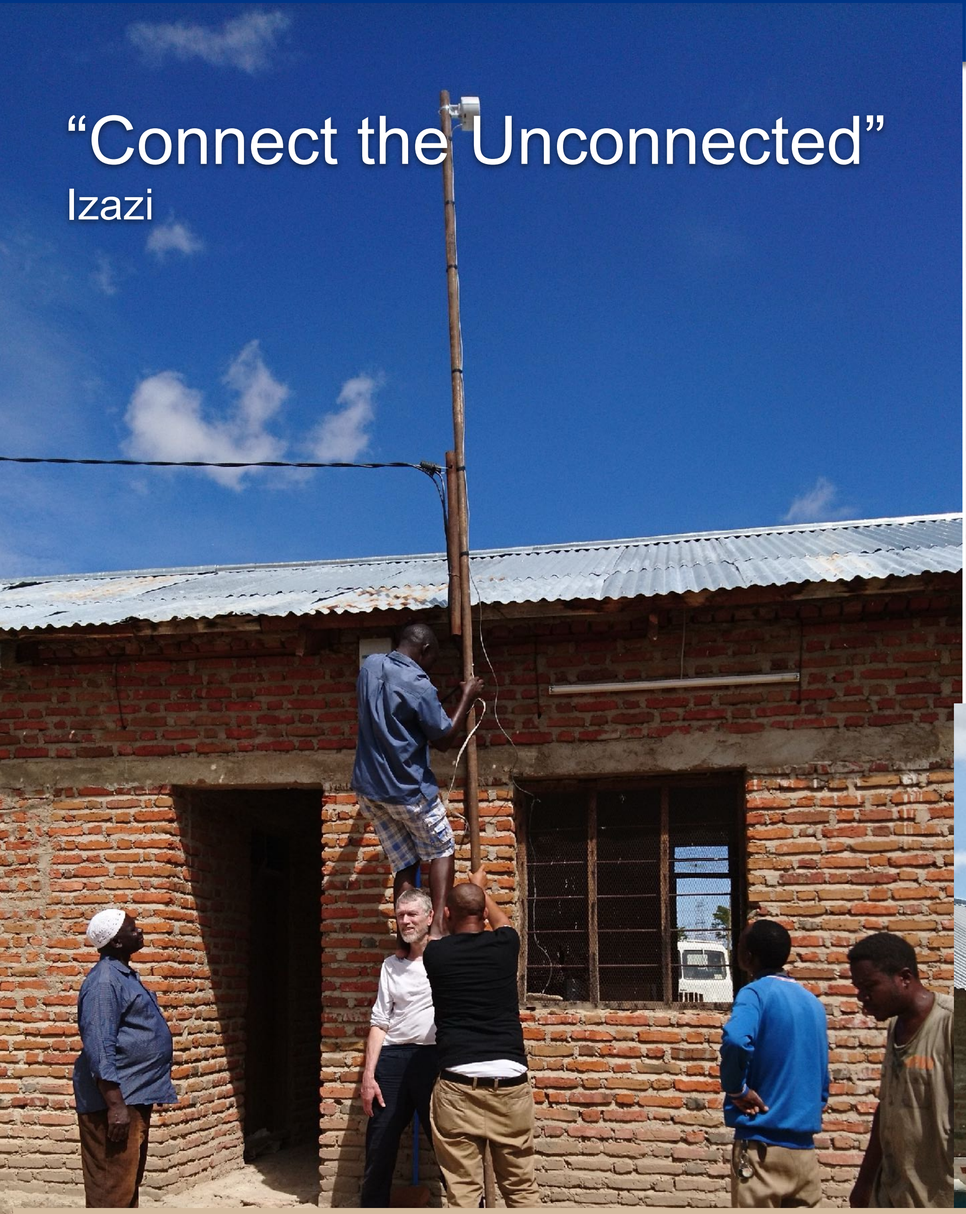
1271 pupils, 34 full-time teachers
9 m pole (above trees) base to connect
- Migoli health station
- Migoli village office

“Connect the Unconnected”

Izazi



Basic Internet Foundation





Installation time: 1,5 h

catching the signal from the Vodacom tower in Migoli (~10km away)

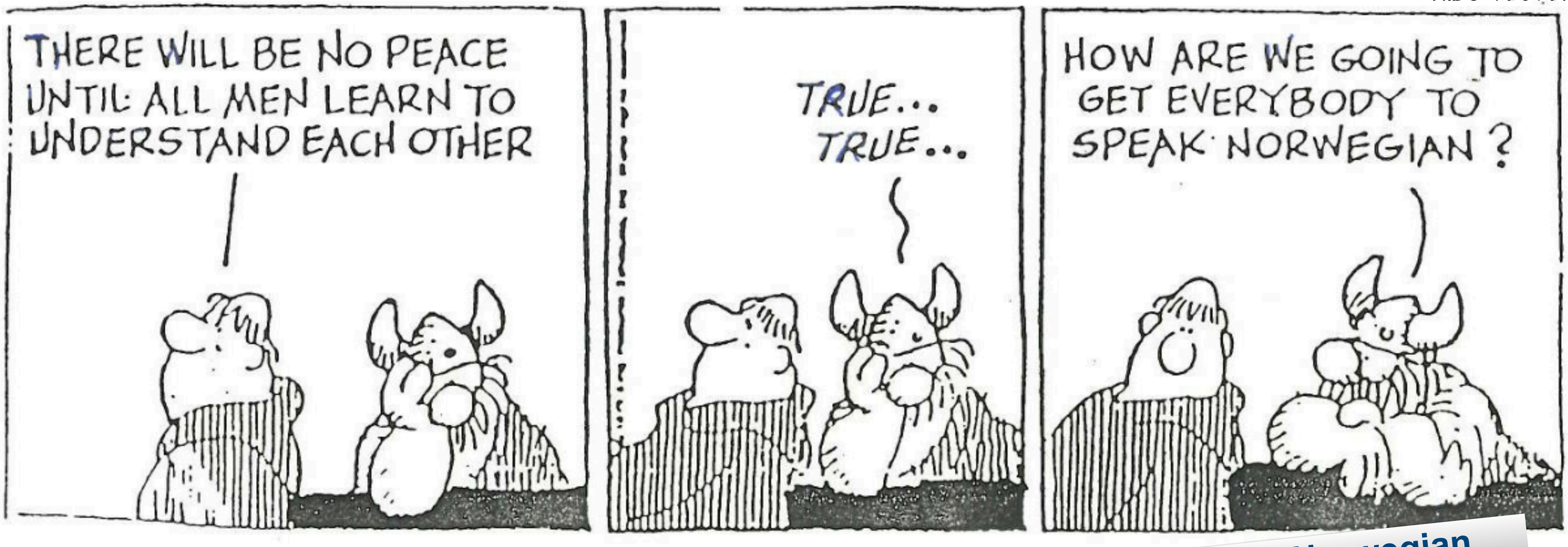
Upcoming Topics / To do for next week

Upcoming Topics

- Radio characteristics

To Do:

- What is the topic you'd like to work on?



teach our sensors to talk Norwegian

Privacy Labels (A-F)
Security classes for IoT systems