Radio Mesh Networking & Distributed Systems

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Trying to be Activist, Independent Researcher & Hacker

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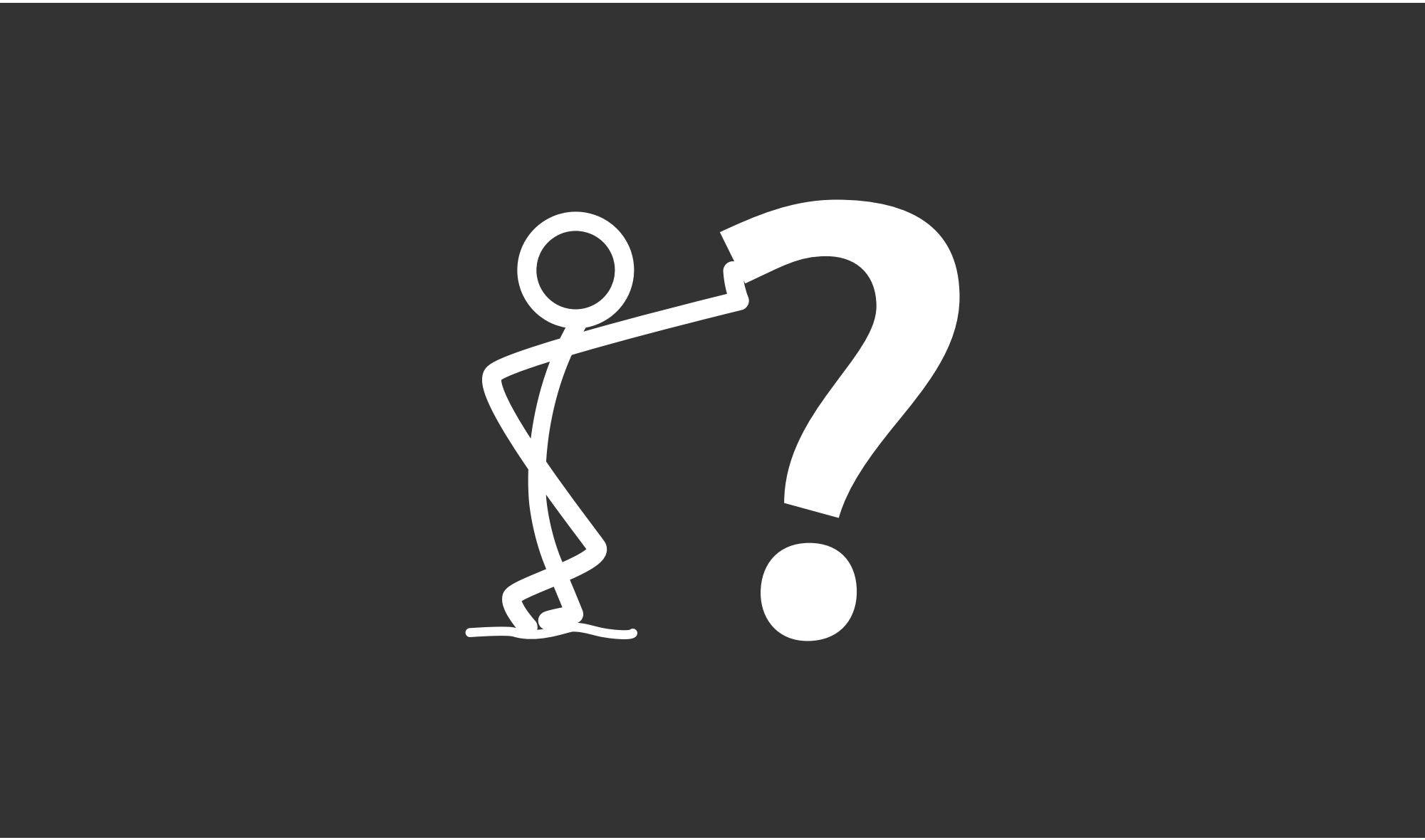
Overview

License

WHY ?



Change

Interest

Frustration

Common guys !, what are the possibilities.... ?

- Building a RMN(Radio Mesh N/W) Locally is itself Fun, Exhilarating
- Great Hobby - similar to Amateur Radio, Astronomy...
- Converging experience of Hardware & Software Equally
- Really get to know mechanism of OSI Layers
- Hack the Physical Layer
- Create & test new protocols

Learning & Sharing


What is a Mesh?


What is a OLSR?


What is a B.A.T.M.A.N?


Where is the J.O.K.E.R?

Am i profiled?


Awesooomeeee !


Asta La GNU !


What is a Wave really?


Chat without Track!

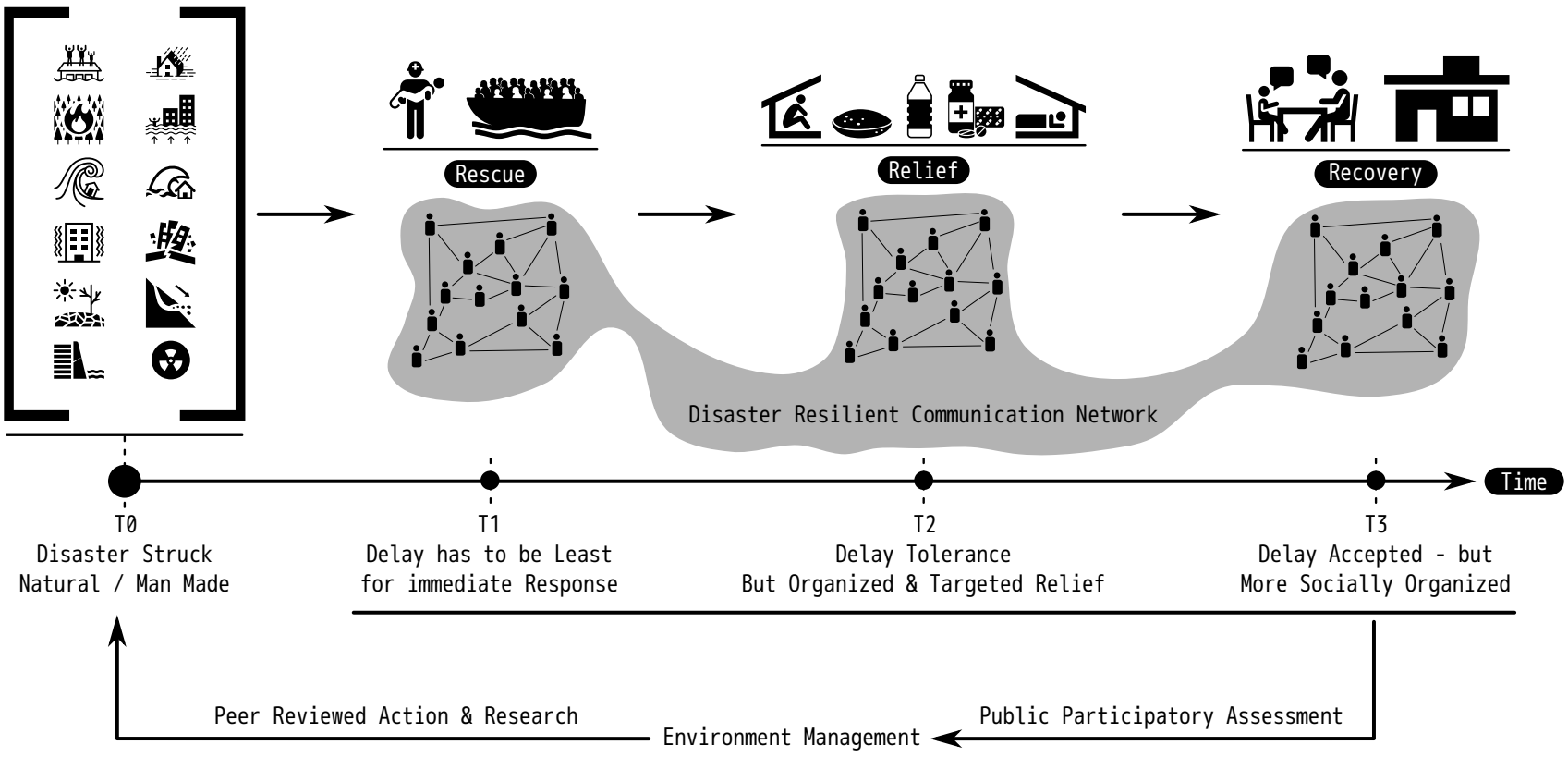

EM wave is like "beebeebebeee"!


Commons Produced?
Aaawesssommee !


Yeah Dude !

Times of Emergency - Disaster & Calamity

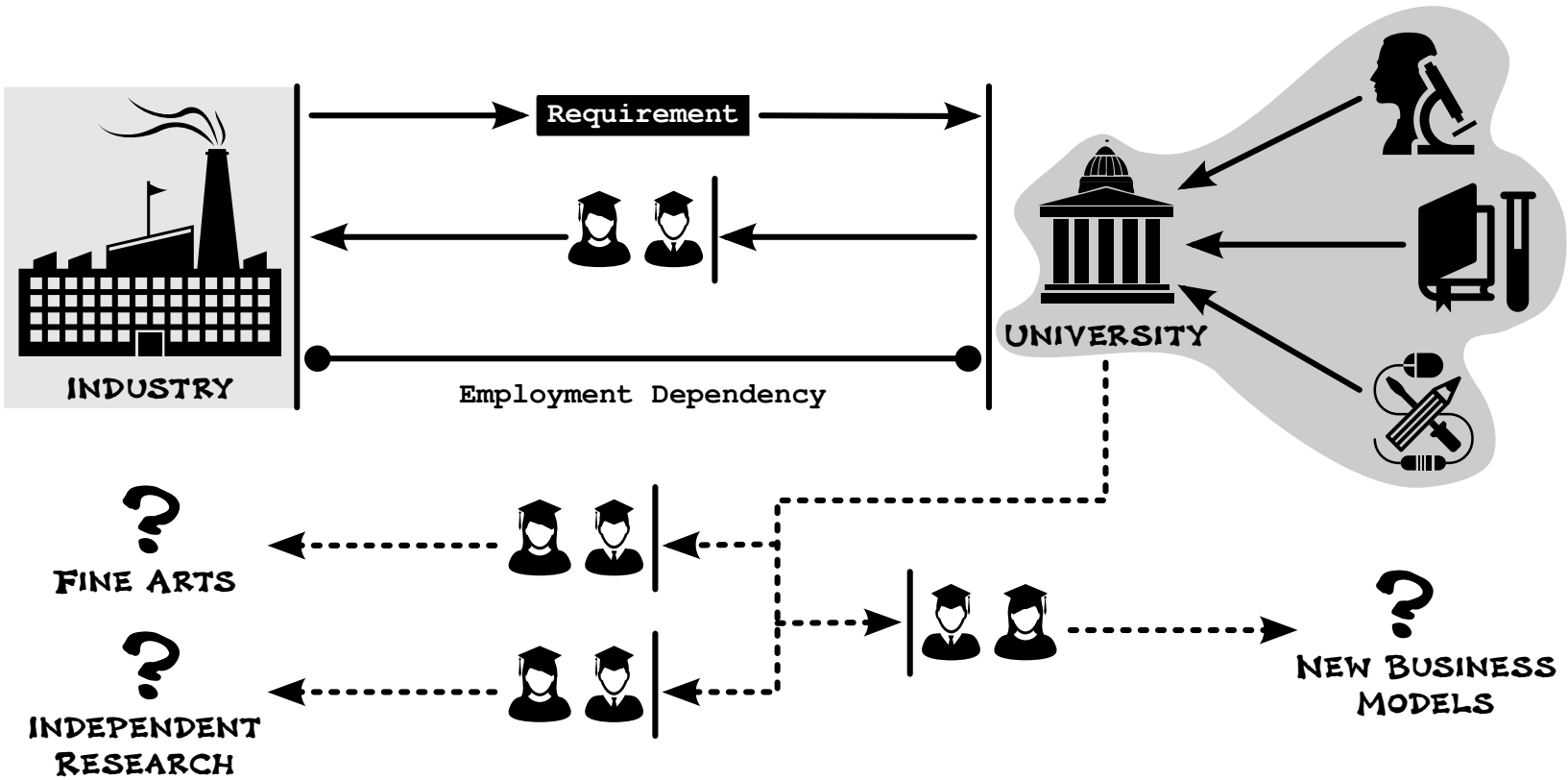
Meshed/Distributed - (Un)Licensed Network play a Vital Role.



Ex: Mesh Networks(Amateur Radio, Community Radio)

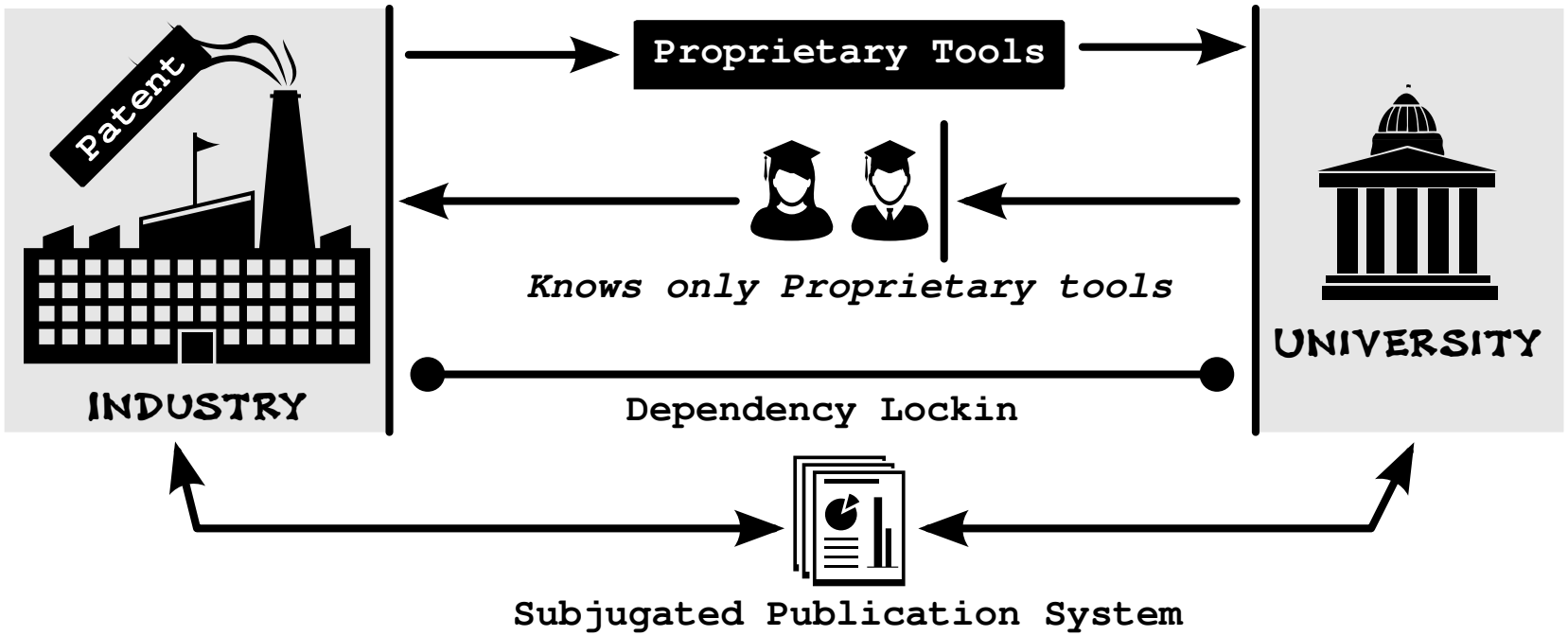
Education & Business Models

Paradigm change in Education & Business Models are necessary



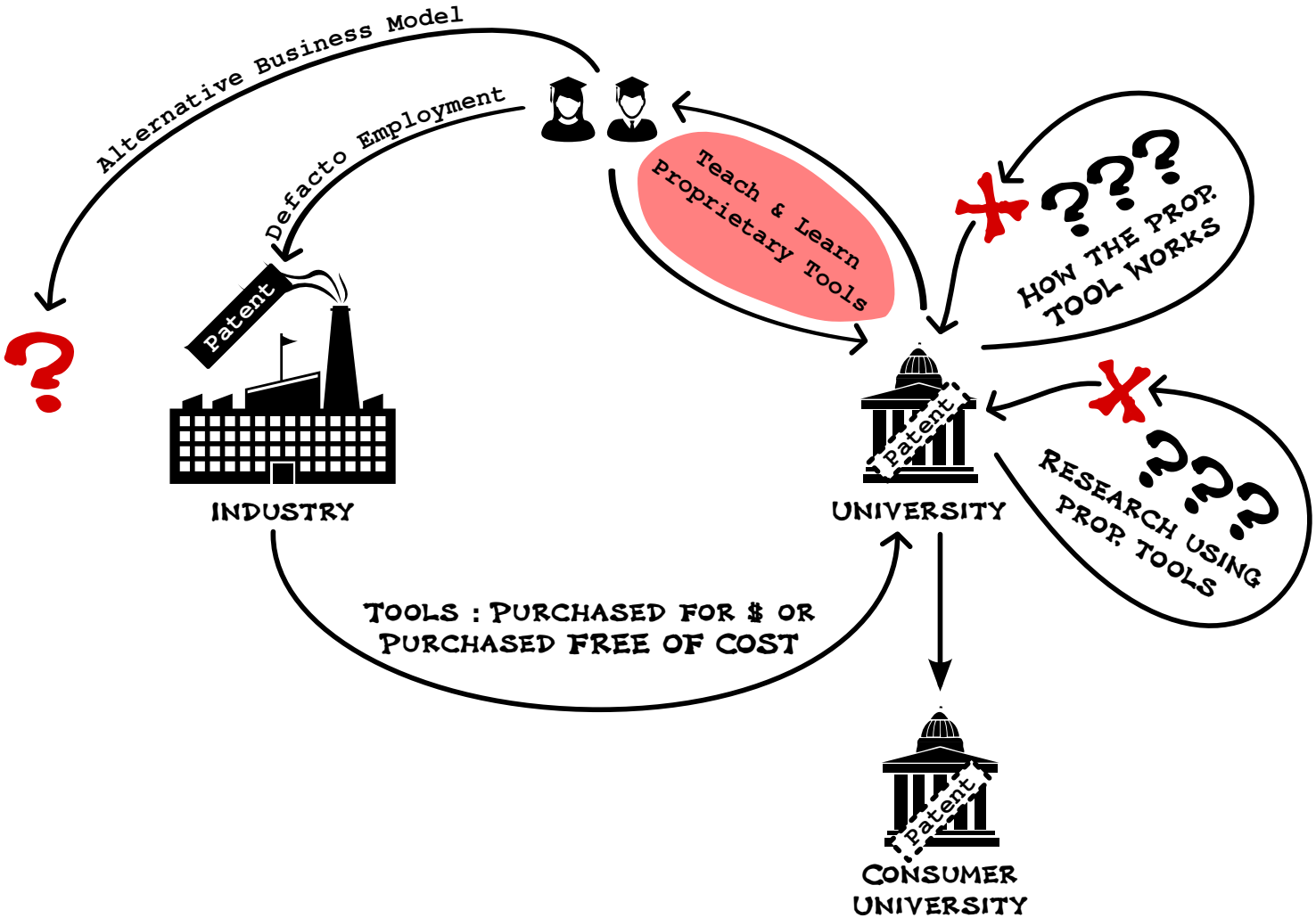
[root]# init0 - Dependency_Lockin

Really ? Common..... be Honest !

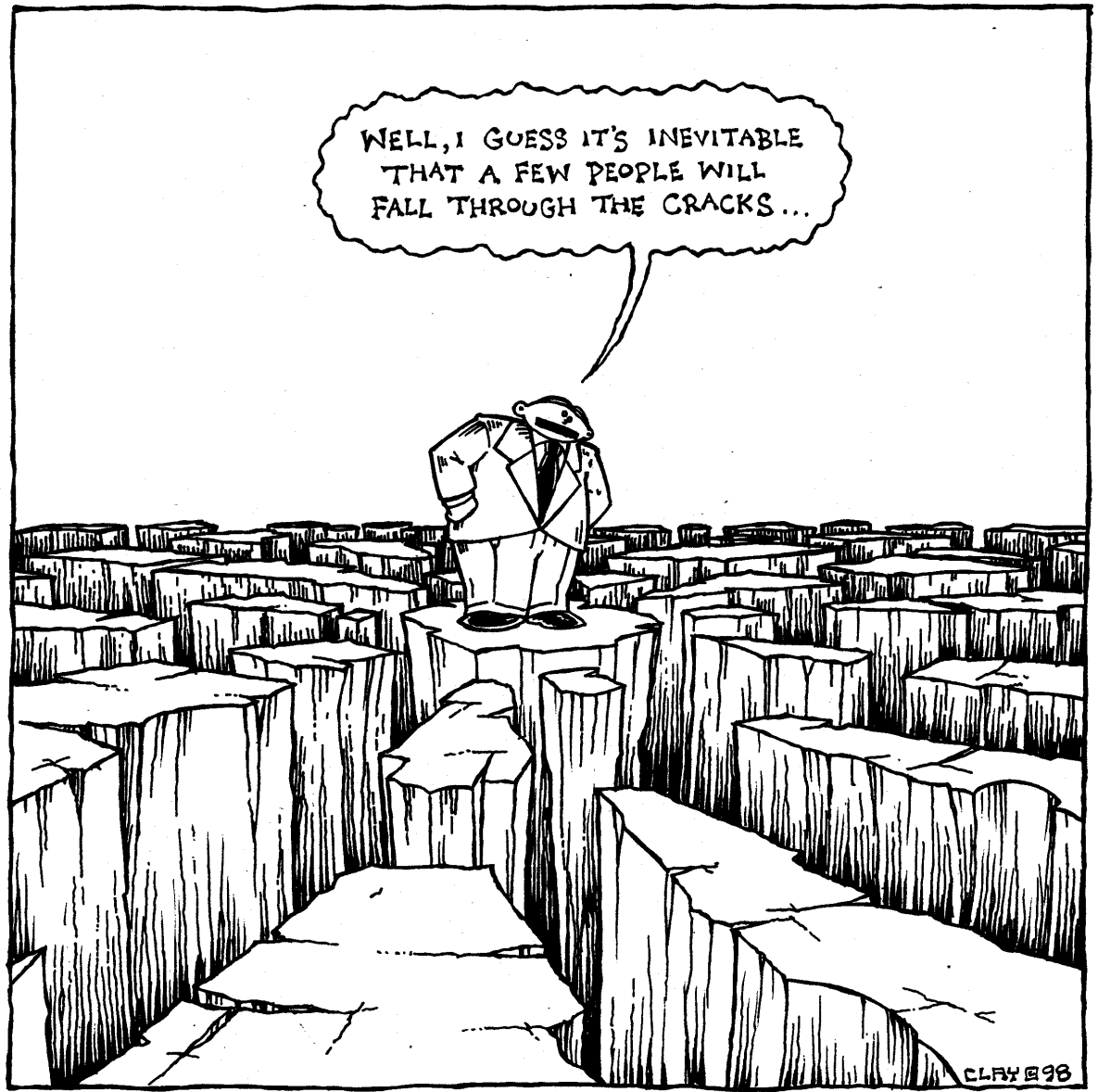


[root]# init0 - Tread_Mills

Is this even possible ???



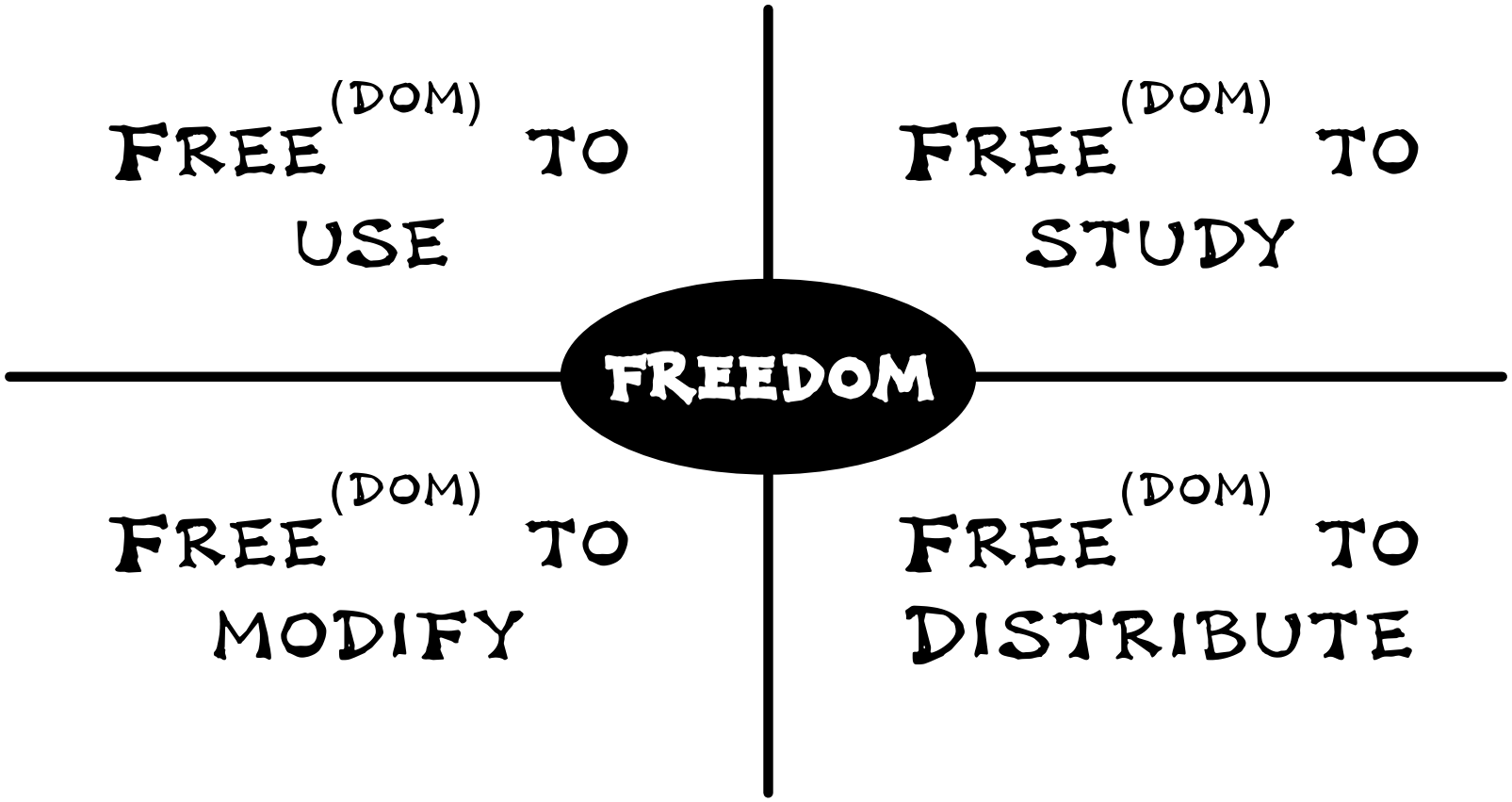
What about Internet ?



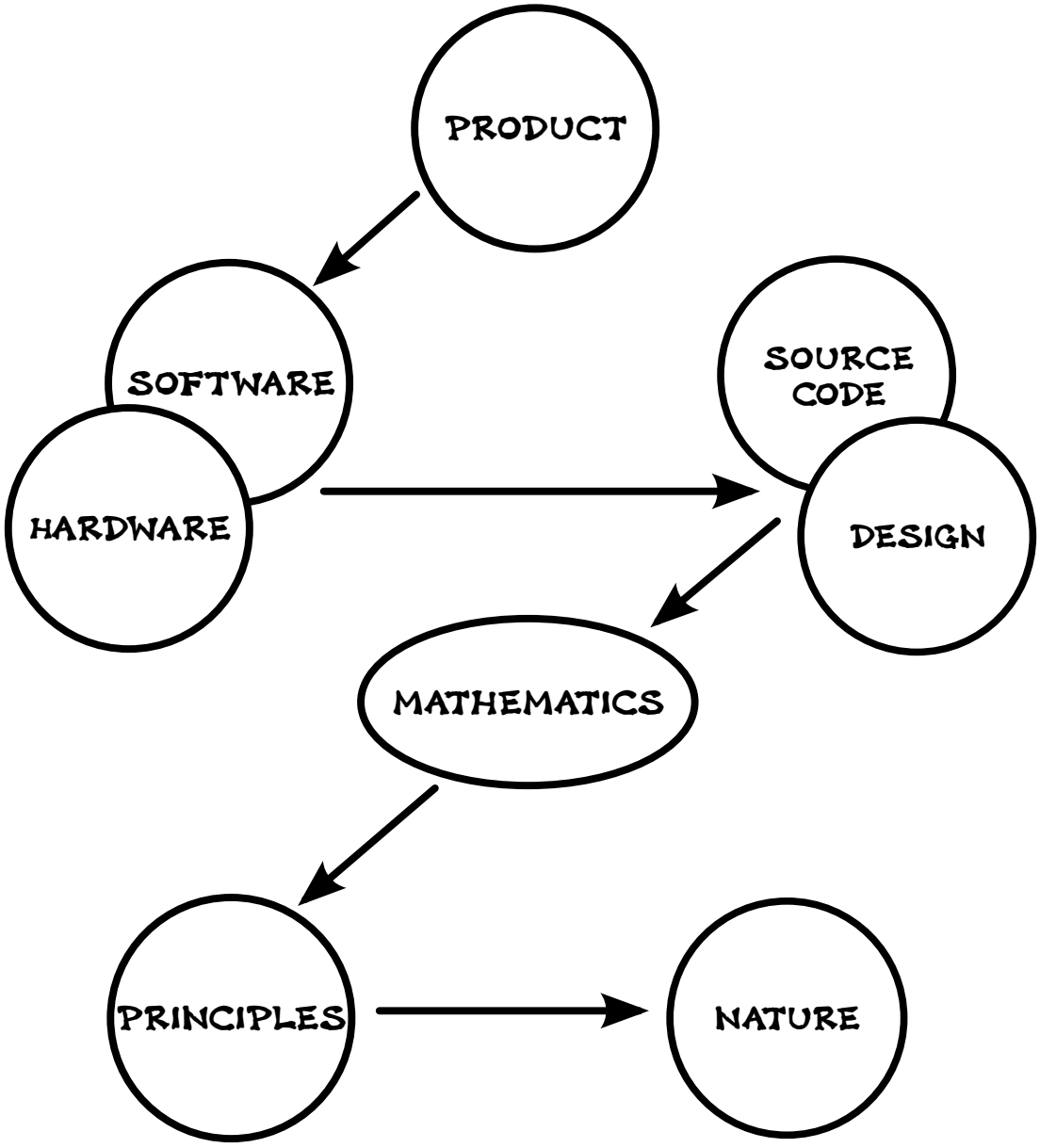
Sidewalk Bubblegum ©1998 Clay Butler

What ?

Four Necessary Freedoms



Affordability - Availability - Accessibility



Radio Mesh Network Infrastructure

Mesh Community = Commons Peer Production + Collaboration

Mesh Medium = (Un)Licensed Spectrum + Shared Channel

Mesh Node = Radio(TX/RX) + Feeder + Antenna

Mesh Service = Framing + Routing + Encryption

Mesh Application = Distribution Framework + Human Touch

Radio Spectrum

Radio Spectrum = Collection of Radio Frequency

Spectrum Usage = Exploration + Communication = E + C

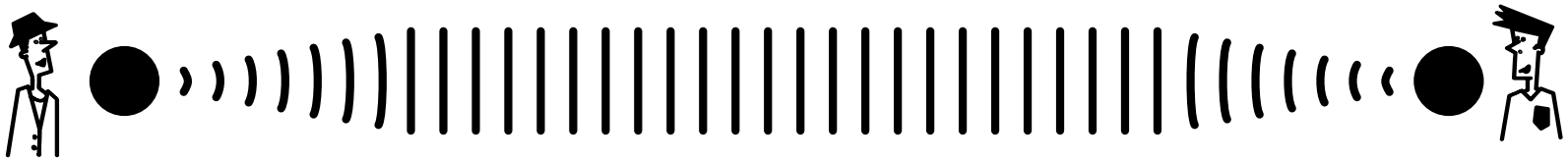
E = Radio Astronomy + Spectroscopy + BioMedical

C = Broadcasting + Telecom + Community Radio + Amateur License

Radio Regulations for **Ethical** Usage

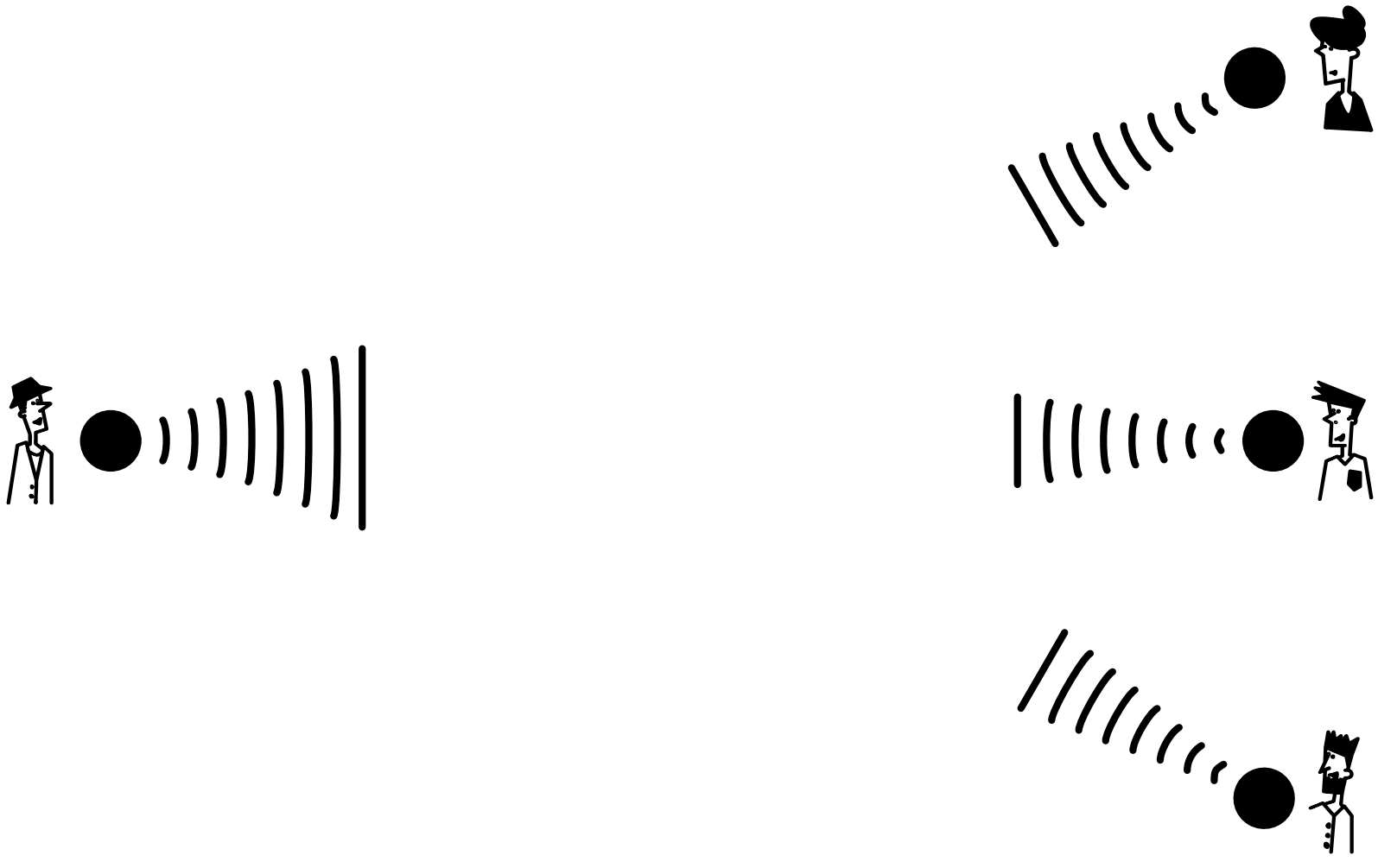
Beware of Radio **Spectrum Adjudication** based on Local Law & Regulation

Radio Mesh Network Connections



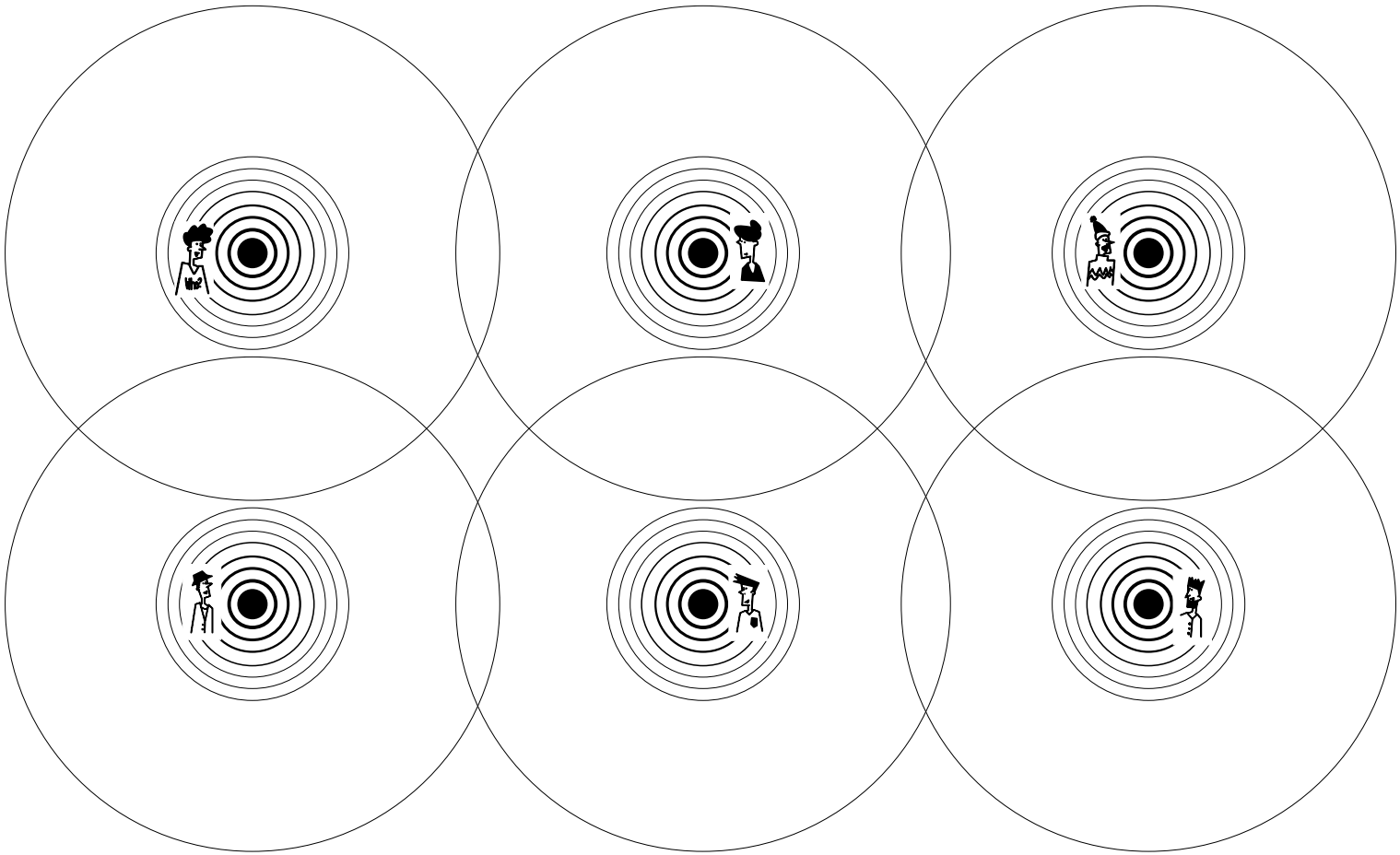
Point to Point

Radio Mesh Network Connections...



Point to Multi-Point

Radio Mesh Network Connections...



Multi-Point to Multi-Point

Radio Mesh Networking

Radio Mesh Network (RMN)

=

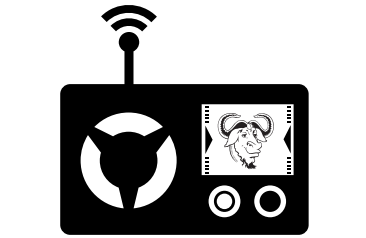
Radio Backbone links *(Adhoc - Mesh Aware)*

+

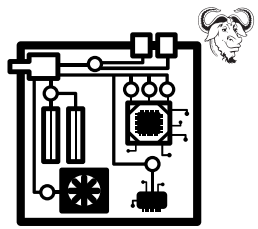
Radio Access-point links *(Infrastrcutre - Mesh Agnostic)*

Awesome ! Convergence

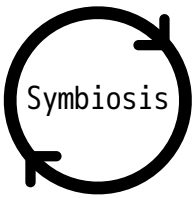
DREW = Desktop + Radio + Embedded + Web



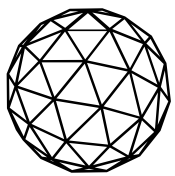
RF Engineering



Embedded Systems



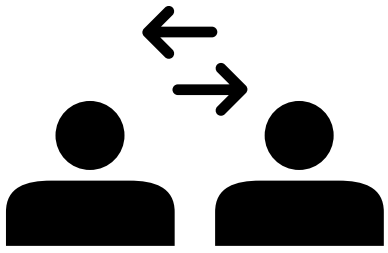
Desktop/Mobile Systems



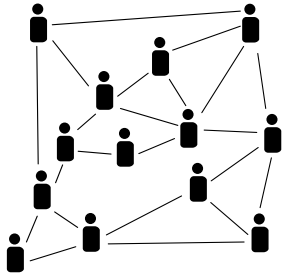
Web Systems

Awesome ! Convergence ...

Distributed Peer to Peer + Collaboration + Cryptography

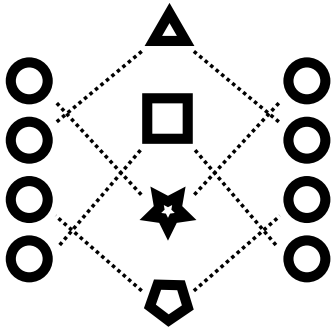


Peer to Peer Systems



Distri-Mesh Systems

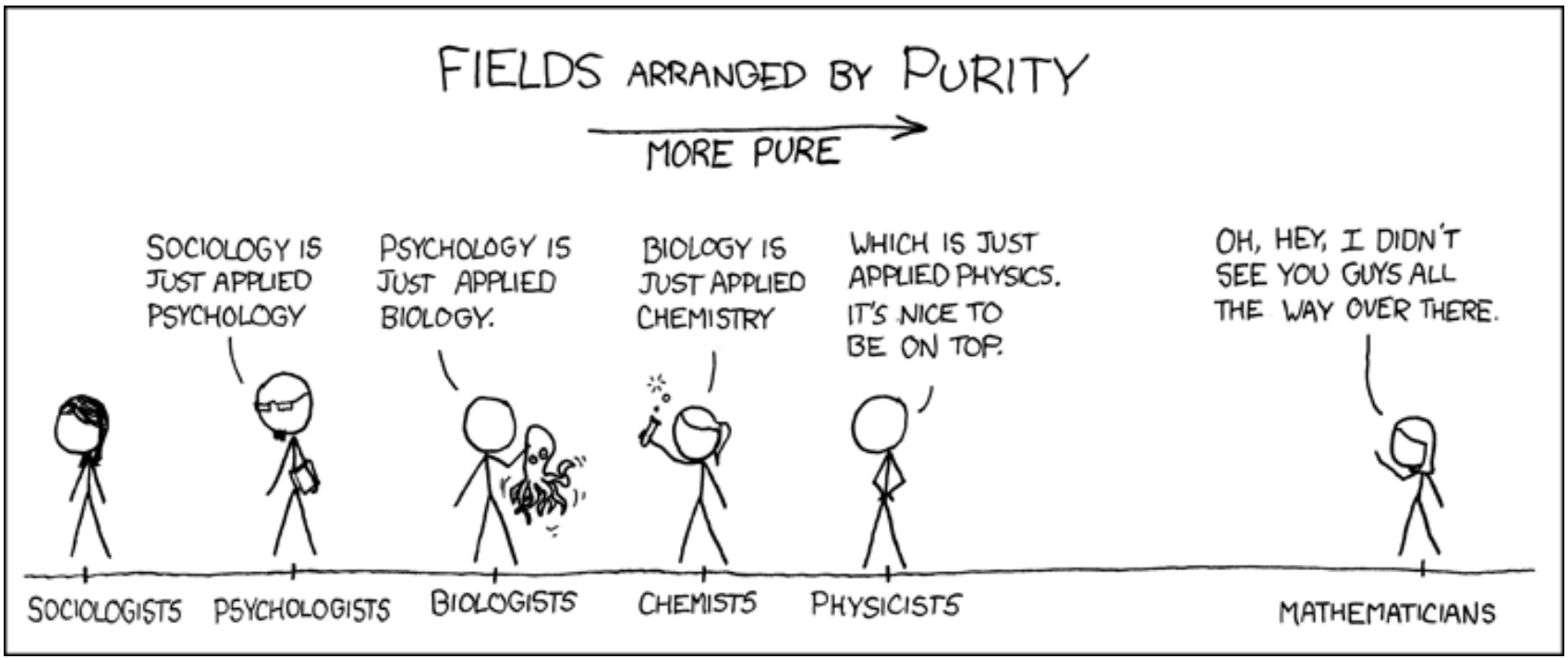
Collaborative Systems

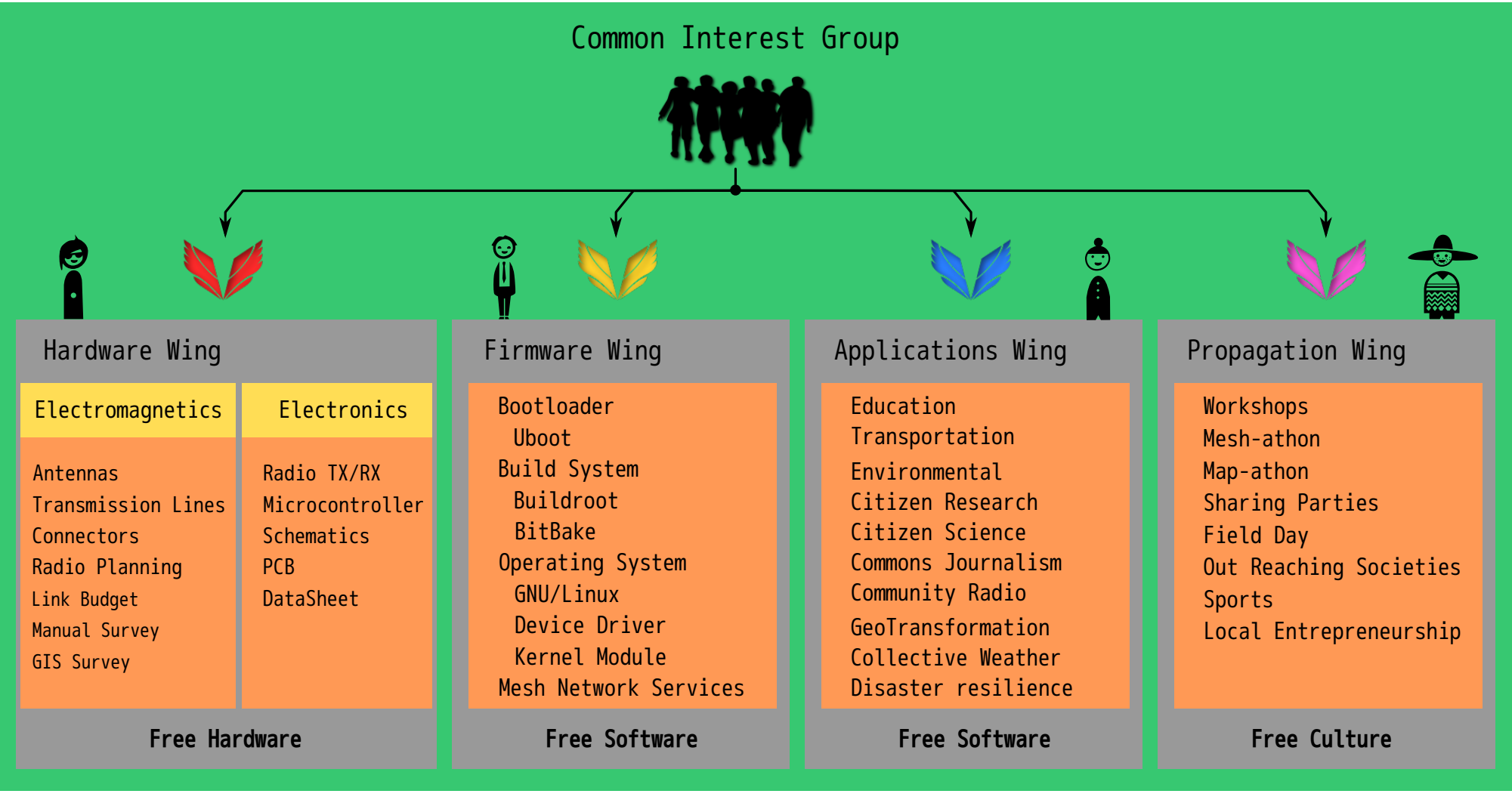


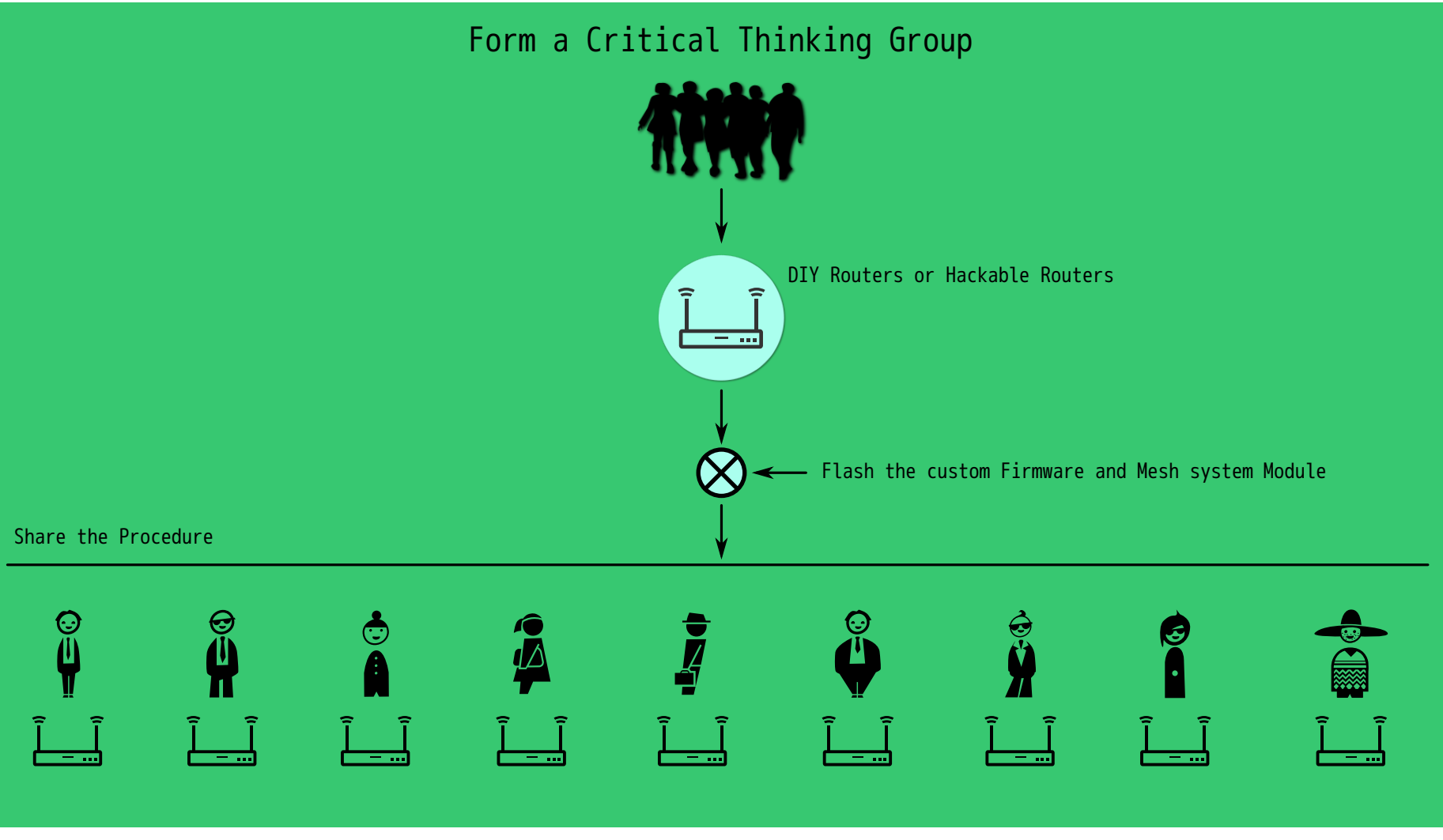
Crypto Systems

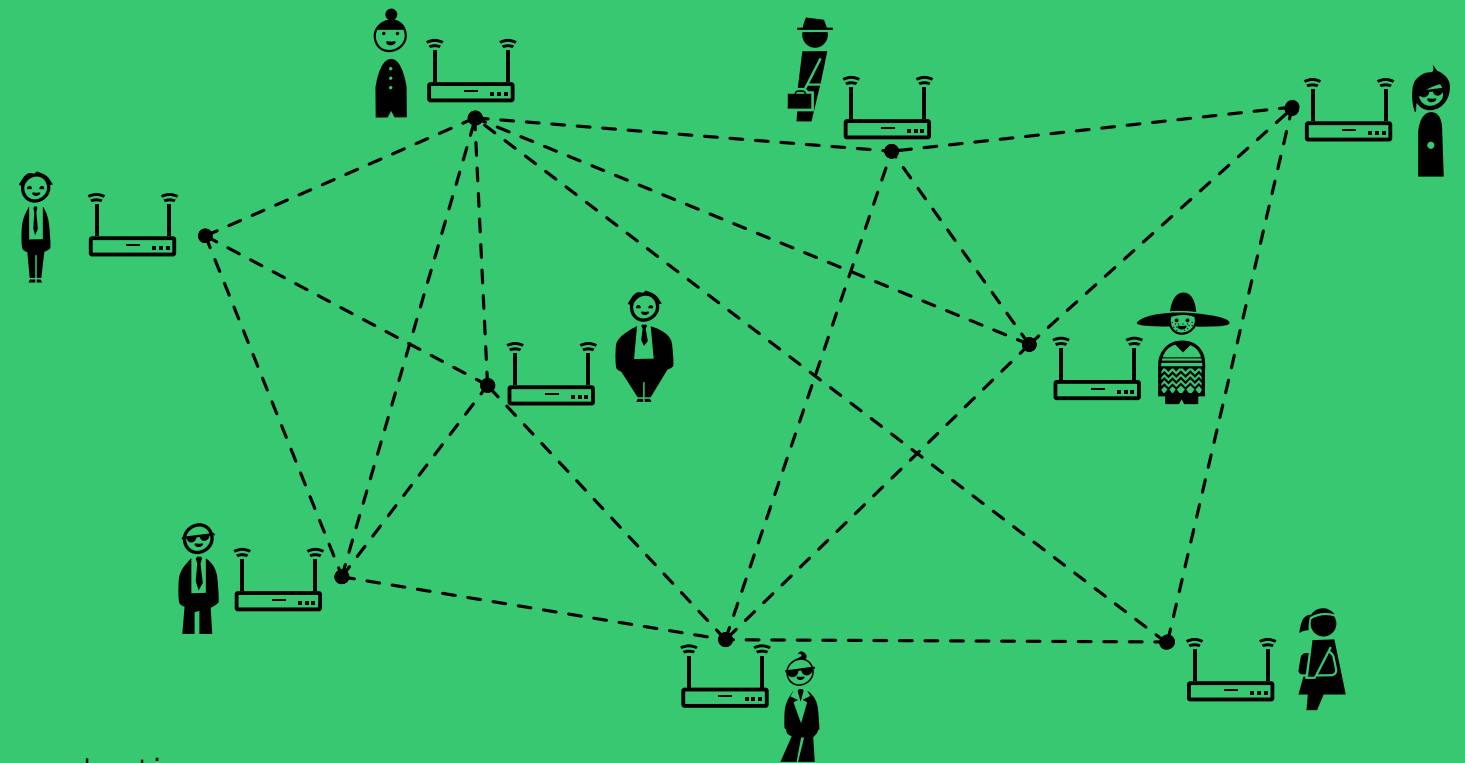
HOW ?

Community in Diversity :p




Common Interest Group
Hardware Wing
Electromagnetics
Antennas
Transmission Lines
Connectors
Radio Planning
Link Budget
Manual Survey
GIS Survey
Electronics
Radio TX/RX
Microcontroller
Schematics
PCB
DataSheet
Free Hardware
Firmware Wing
Bootloader
Uboot
Build System
Buildroot
BitBake
Operating System
GNU/Linux
Device Driver
Kernel Module
Mesh Network Services
Free Software
Applications Wing
Education
Transportation
Environmental
Citizen Research
Citizen Science
Commons Journalism
Community Radio
GeoTransformation
Collective Weather
Disaster resilience
Free Software
Propagation Wing
Workshops
Mesh-athon
Map-athon
Sharing Parties
Field Day
Out Reaching Societies
Sports
Local Entrepreneurship
Free Culture


Form a Critical Thinking Group
DIY Routers or Hackable Routers
Flash the custom Firmware and Mesh system Module
Share the Procedure



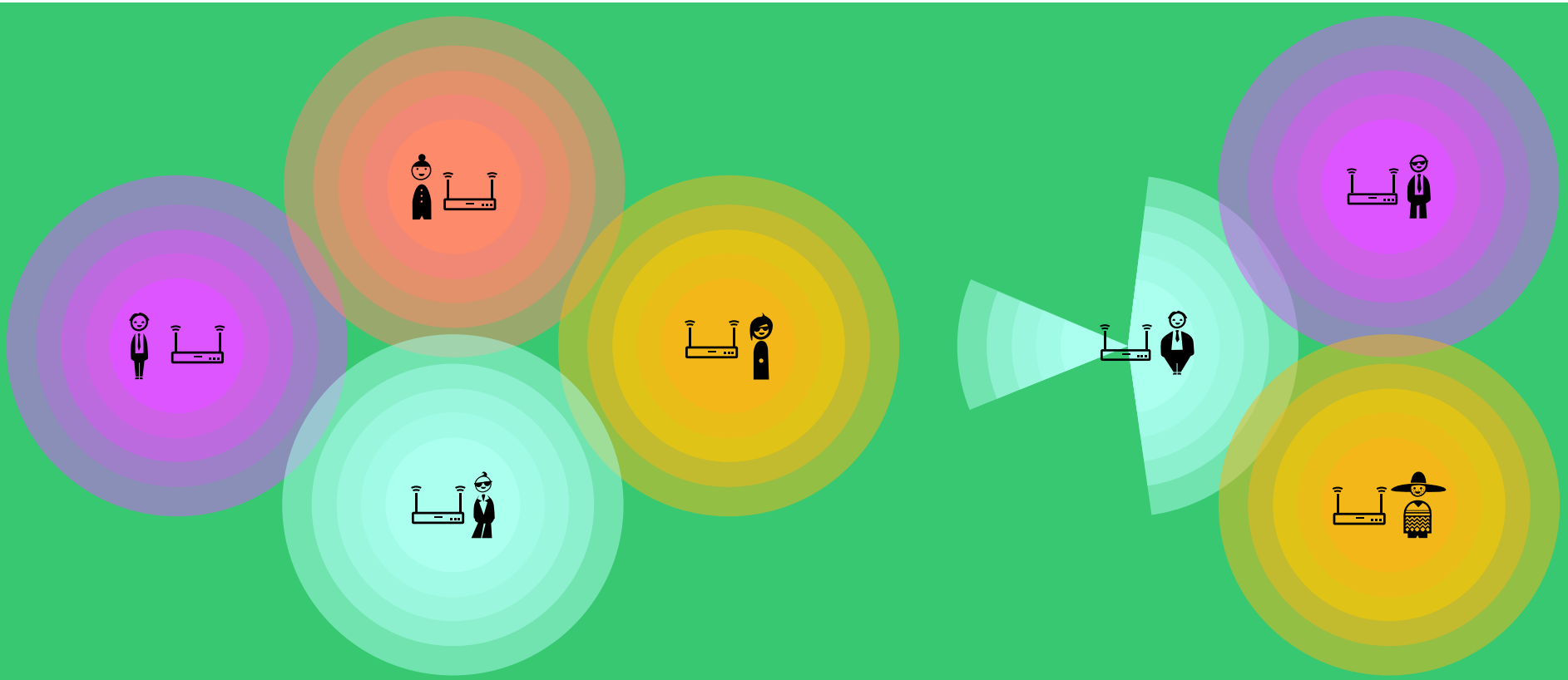
Select a common Location

Start connecting with each other

Test by increasing the density

Test by moving around

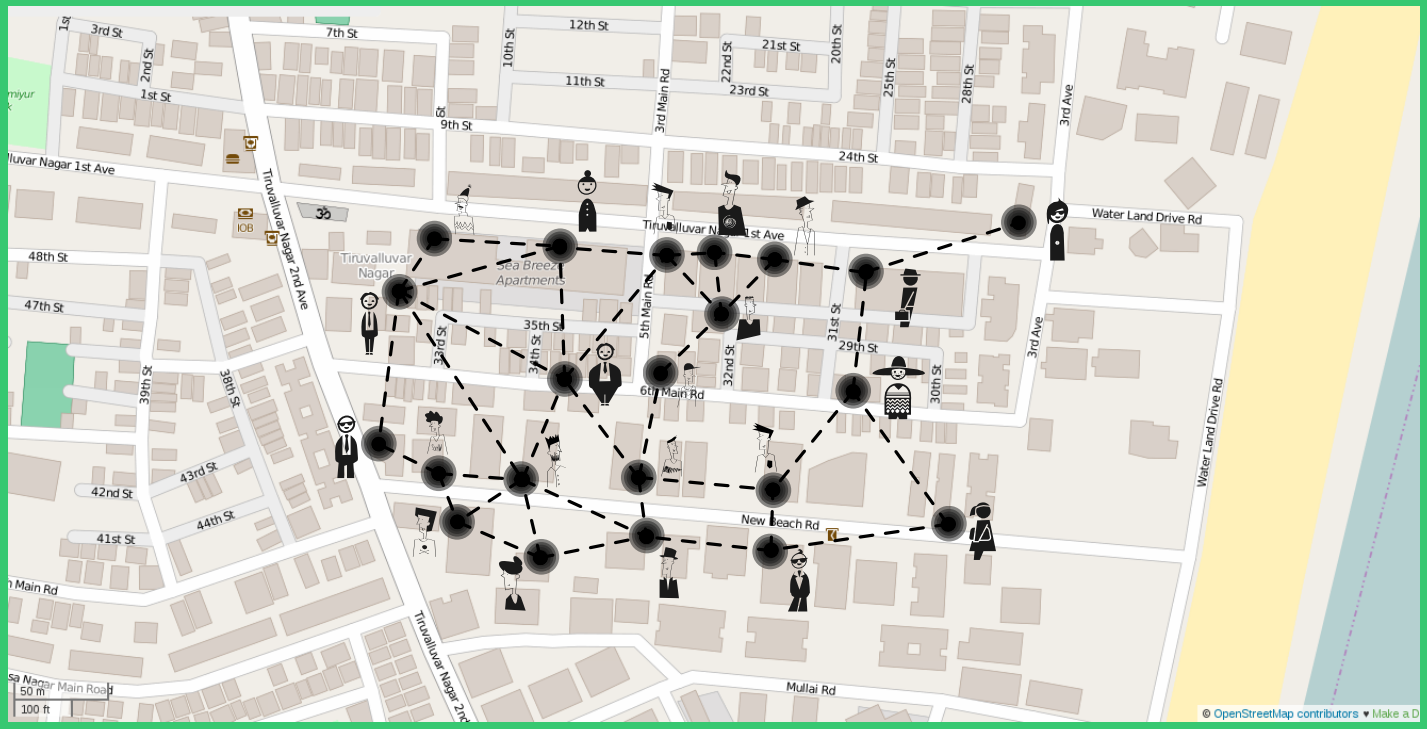
Understand the Networks Scalability, Efficiency, Effective Range, Quality by measuring Network Parameters



Choose a Local Area Geography - with optimum distances overlapping each routers effective range

Mount the Routers, Supply power (Mains powered or Reneweable Powered)

Try to Connect with another peer in adjacent geographical area using Line of Sight Connection

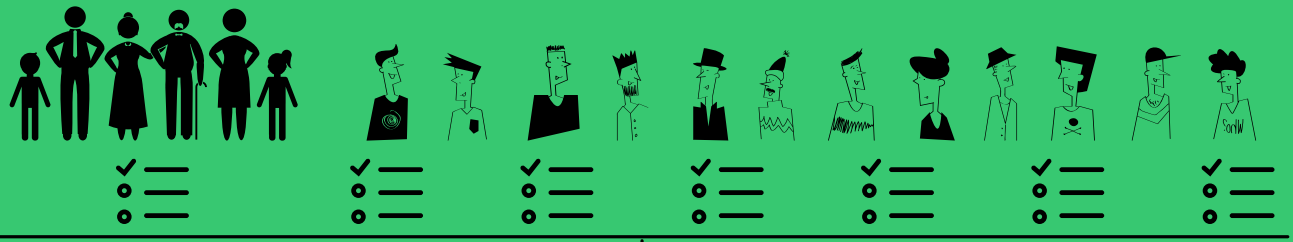


Choose a Local Area Geography - Map their locations in Community map application

Fire up the Antennas, Radios, Routers, Form the topology

Try to Establish the Mesh Network

Discover Requirments
of Local People



Develop applications
to meet those
requirements

Organize Public
Meetings

Make them Participate
Make them Use the Network
in Interesting Ways !!!

Symbiotically relate Local Business Ecosystem & Education with the Mesh Network Infrastructure

HARDWARE

When it comes to Physics, Ground Work & Hardware

– – – – – – – –

i have seen people GO LIKE THIS !!!

Me ??????

– – – – – – – –

YEAH !!! Me Tooooooooooooo !

Spectrum Activism

EM Spectrum $\equiv$ Water, Land, Atmosphere

- - - - - -

- A channel (frequency/band) becomes a resource
- Resource mgmt. between Stake Holders(SH)
- SH = Commons + Fraternities + Establishments
- Resource mgmt. through Mutual sharing strategy
- Resource mgmt. through "Regulatory" agencies

Which Spectrum for RMN ?

Licensed $\equiv$ (Amateur, Military) Bands

Unlicensed $\equiv$ (ISM, Wifi) Bands

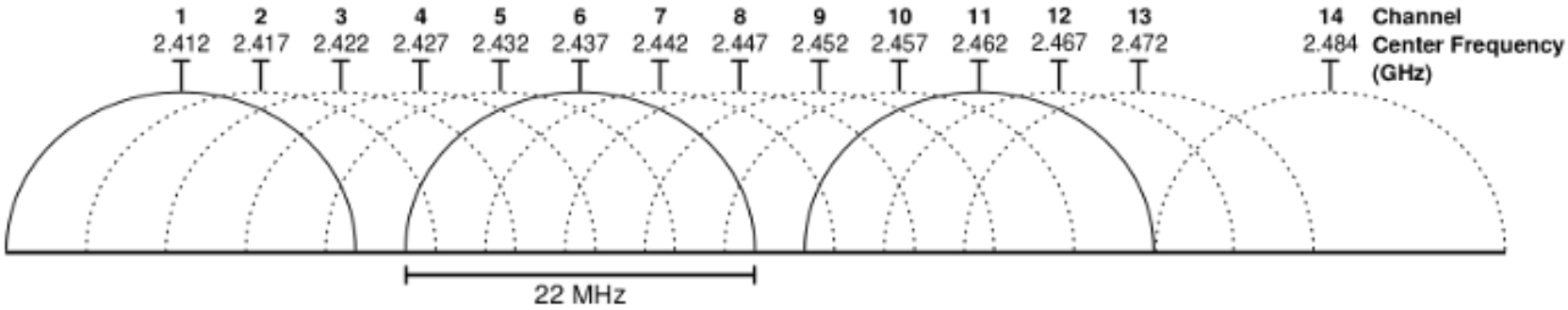
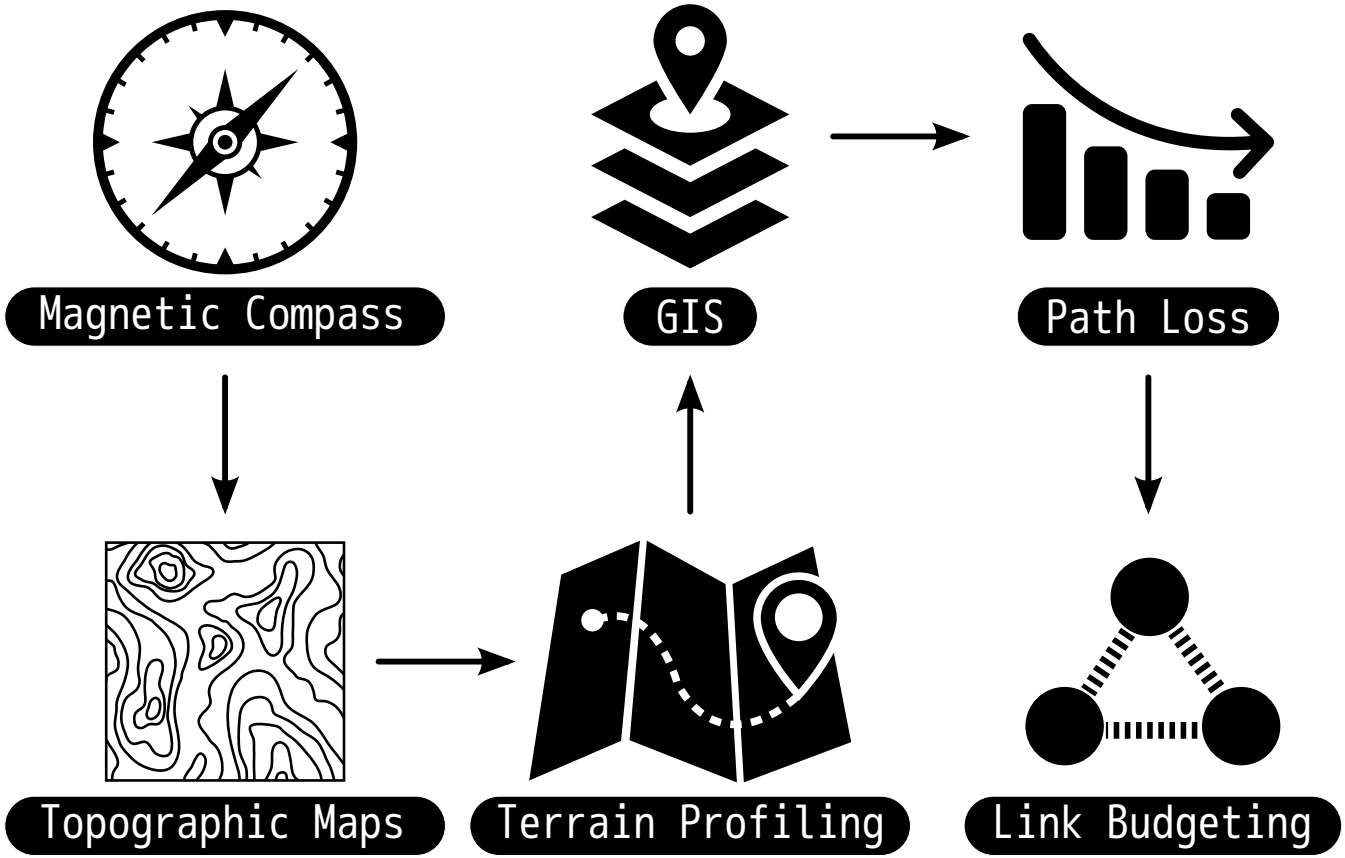


Figure: 2.4GHz Wifi Band

Radio Planning, Budgeting

$\equiv$ Survey, Geography, Material, Resources



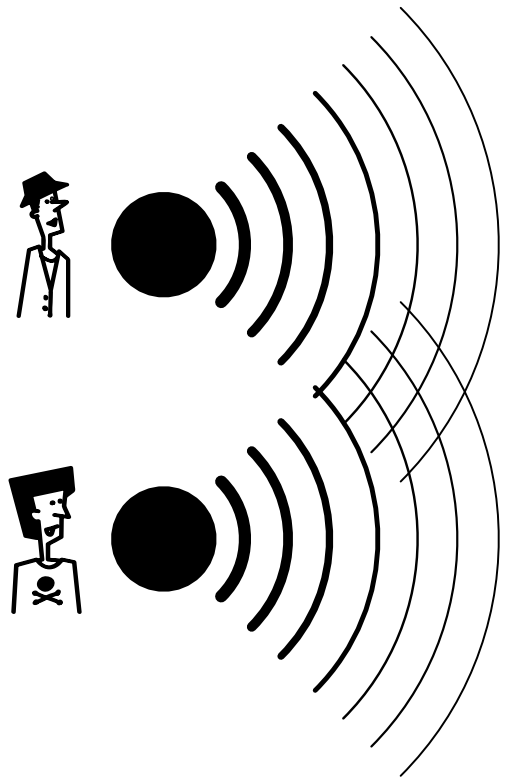
Antenna & Radiation

$\equiv$ Eyes, Ears, 7/11 Mouth

1. Resonance, Frequency, Phase, Amplitude
2. Propagation, Reflection, Refraction, Diffraction, Scattering
3. Constructive & Destructive Interfernece
4. Standing Wave, Reflections & Matching
5. Antenna Gain, Directivity, EIRP
6. Bandwidth - Narrow Band & Broad Band
7. Multipath Channeling = SISO, SIMO, MISO, MIMO
8. Free Space Path Loss

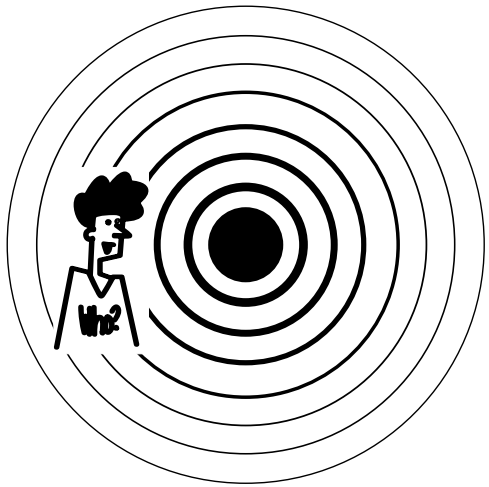
Phase, Frequency, Amplitude

What happens during Interference - Construction ? Destruction ?



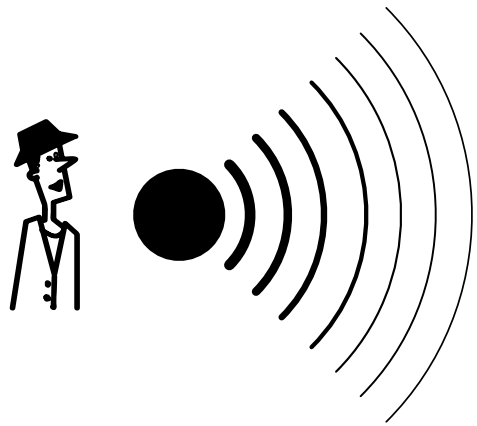
Ever heard of Double Slit Experiment ??

Omni-Directional Antenna



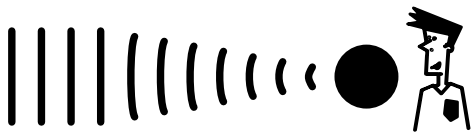
List

Sectoral Antenna



List

Highly Directional Antenna



List

How we Designed an Yagi-Uda Antenna ?

Scavenging Resources

$$\text{DIY} = \text{Scavenge} + \text{Upcycle} + \text{Repurpose} + \text{Hacking}$$

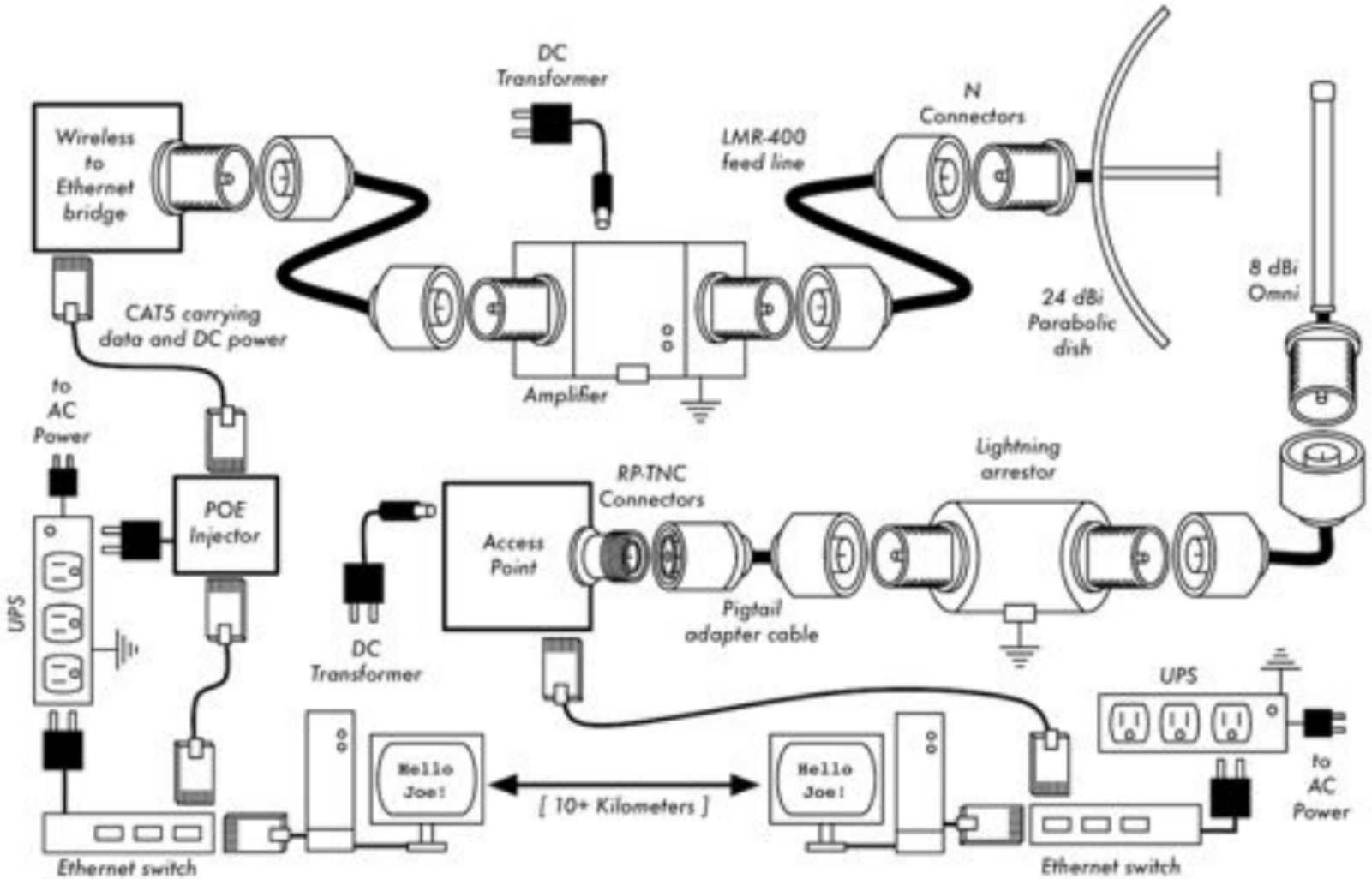
RF Feeds & Connectors

$\equiv$ Nerves

1. Wave Guiding, Skin Effect
2. Standing Wave, Reflections & Matching
3. Cable Loss, Filter effect
4. Connectors, Insertion Loss

RF Feeds & Connectors...

Could U see why i called them **Nervesssss** ?



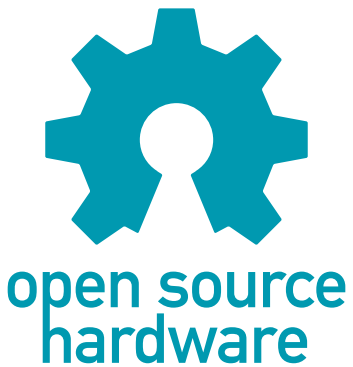
Radio & Embedded Hardware

$\equiv$ Mushy Mushy Organs

1. Stable RF Oscillator
2. RF Controller
3. Frequency, Amplitude, Phase Control
4. EM Regulation policy
5. Matching, Mixing, Conversion
6. Modulation, Demodulation, Encoding, Decoding
7. Filtering, FPGA, DSP

Free Projects :)

Atlast !

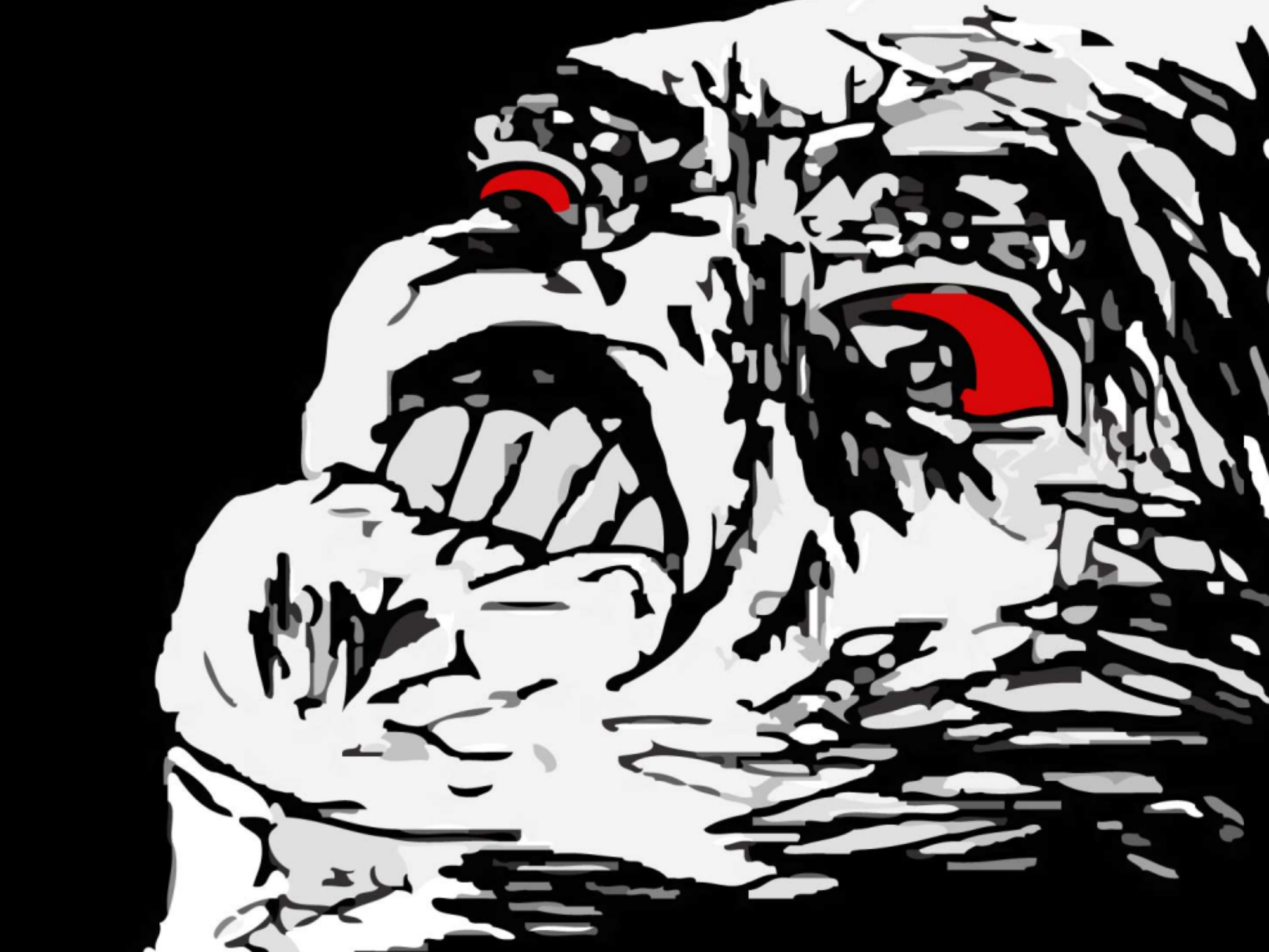


Past, Present, Future

1. Past
   - 1.1 DX, APRS, WSPR
   - 1.2 Software Controlled Radio
2. Present
   - 2.1 HSMM, Community Wireless Networks
   - 2.2 Software Defined Radio, FPRF modules
   - 2.3 Cognitive Radio, Fractal Antennas
   - 2.4 Spectrum Activism, Emergency Resilience
   - 2.5 Citizen Research, Science, Journalism
3. Future
   - 3.1 Configurable & Origami based Antennas
   - 3.2 Affordable Meta-material Antennas
   - 3.3 Grass Roots Telecommunication
   - 3.4 Self Regulating, Self Healing Networks

SOFTWARE

When it comes to Software - Myself - GO LIKE THIS !!!



Router Firmware

```
#include <gnu/linux>

int void proprietary_hardware() {
char*[ ] OS = { "OpenWRT", "DDWRT", "Byzantium", "MeshPotato", "Custom_Build" };

switch(OS) {
case("OpenWRT") {Check_Compatibility(); flash_os(OS);}
case("DDWRT") {Check_Compatibility(); flash_os(OS);}
case("Byzantium") {Check_Compatibility(); flash_os(OS);}
case("MeshPotato") {Check_Compatibility(); flash_os(OS);}
case("Custom_Build") {Check_Compatibility(); flash_os(OS);}
}

if(router == BRICKED) {
printf("calm down");
try(reset_button());
if(router == STILL_BRICKED) {
try(serial_flashing_uboot_mode());
}
}

configure(wifi);
configure(access_point, adhoc);
configure(batman,install);
configure(configure_DHCP);

if(web_interface == NULL) {
try(ssh_root_access);
reset(all_network_settings);
}
else {
router_state = BRICKED ;
}

return(0);
}
```

Custom Build is Awesome...

- That's what learning is about
- Learn GNU/Linux for Embedded targets
- Writing Device Drivers + Kernel modules

Mesh Networking Protocols + Services

In RMN we share a common medium (channel)

- Routing becomes Vital
- Layer 3 Routing like OLSR
- Layer 2 Routing like B.A.T.M.A.N
- Plenty of room for new protocols & experimentation
- Peer Identification Mechanism
- PKI Cryptography @ Session & Application Layers
- Distributed Hash Table @ Session & Application Layers

P2P + Distributed Applications

Services & Apps that fits P2P & Distributed, archs. are need of the day !

- Services that reduces information logistics
- Services that gaurantees Privacy
- Services that considers every node equal
- Services that require only knowledge as entry point with very minimal cost
- Apps. that Targets Local First - strategy
- Apps. that helps solve common social problems have great socio-economic impact
- Help shift from Central markets to Distributed & Collaborative markets
- Help Transform devices from Information Appliance to Computing Appliance

That's All Folks :)

Whaaaaaaat ??? Still want more !

- - - - - -

Something is definitely wrong dude :P

Credits

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