Research Update
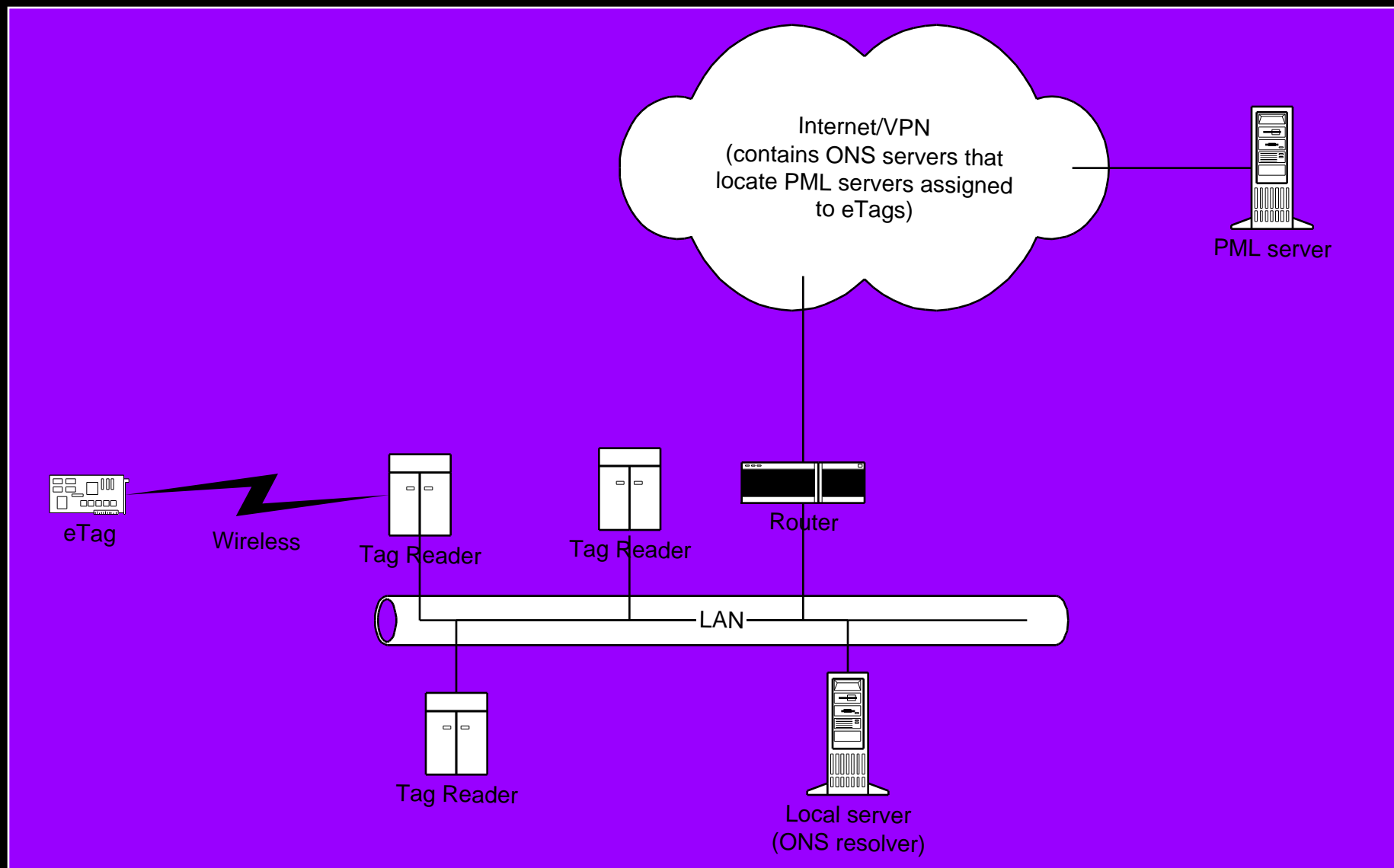
Sanjay Sarma, MIT

Research at the Auto-ID Centers

- **MIT**
  - Infrastructure
  - Initial applications
  - Initial business case
- **Cambridge**
  - Applications
    - Especially manufacturing sector
    - System control
  - Extended Infrastructure

Outline for MIT

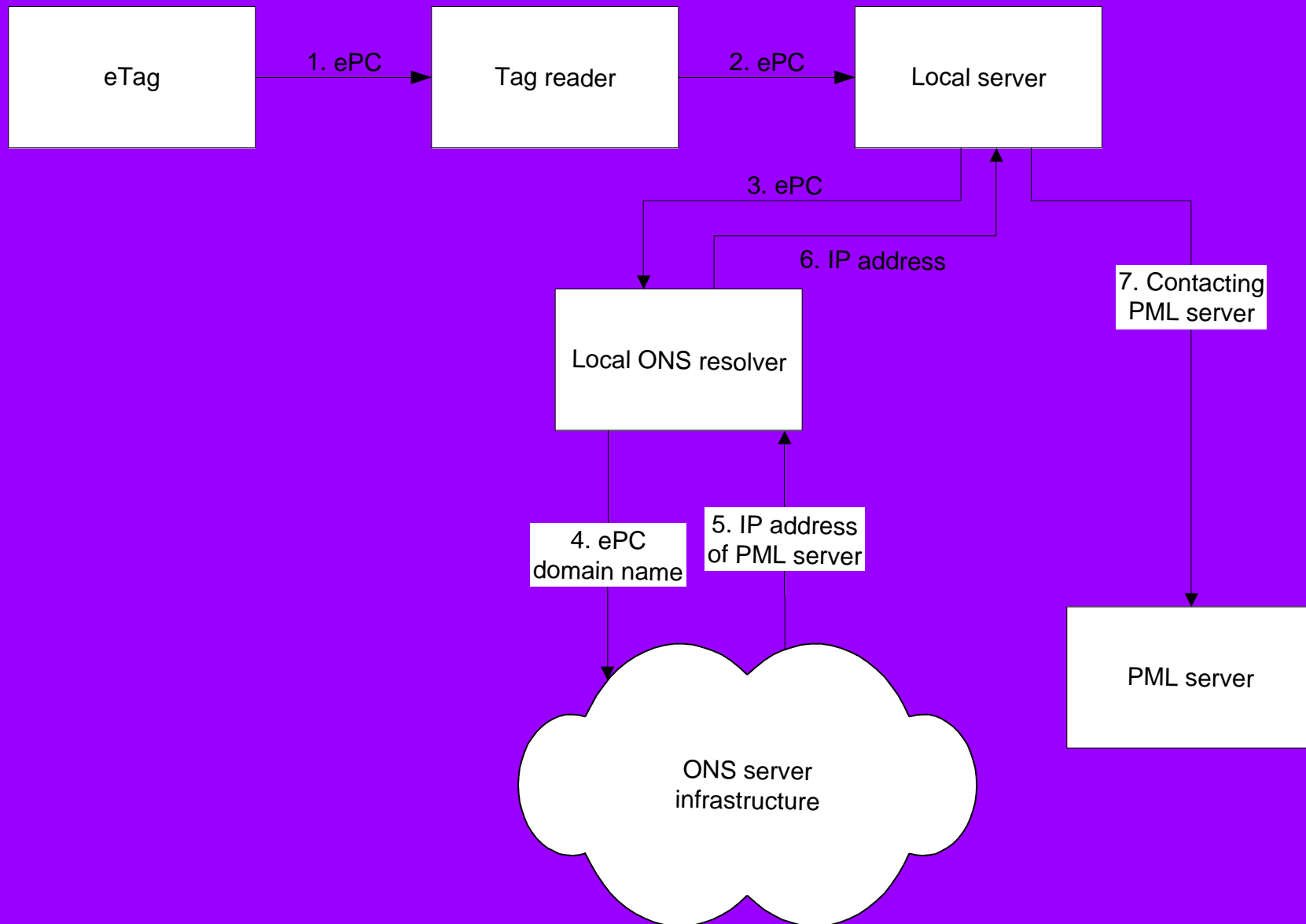- **ePC**
- **Software**
  - ONS
  - **Data Logging Architecture**
  - **Mining**
- **Hardware**
  - **Tag**
  - **Reader**
  - **Network**
- **Language**
- **Personnel and theses**

ONS
Domain Name Service: RFC 1 034, 1 035

ONS Steps

```
┌──────────┐   1. ePC   ┌──────────┐   2. ePC   ┌──────────┐
│   eTag   │──────────▶│Tag reader│──────────▶│Local server│
└──────────┘           └──────────┘           └──────────┘
```

3. ePC

6. IP address

7. Contacting PML server

Local ONS resolver

4. ePC domain name

5. IP address of PML server

ONS server infrastructure

PML server

ONS Syntax

<serial-number ≪product-ID ≪manufacturer-ID ≪version-number ≪root-domain <

- **The mapping between DNS domain names and IP addresses is held in DNS Resource Records (RRs). Details of various DNS RRs can be found in RFC1 034 and 1 035.**
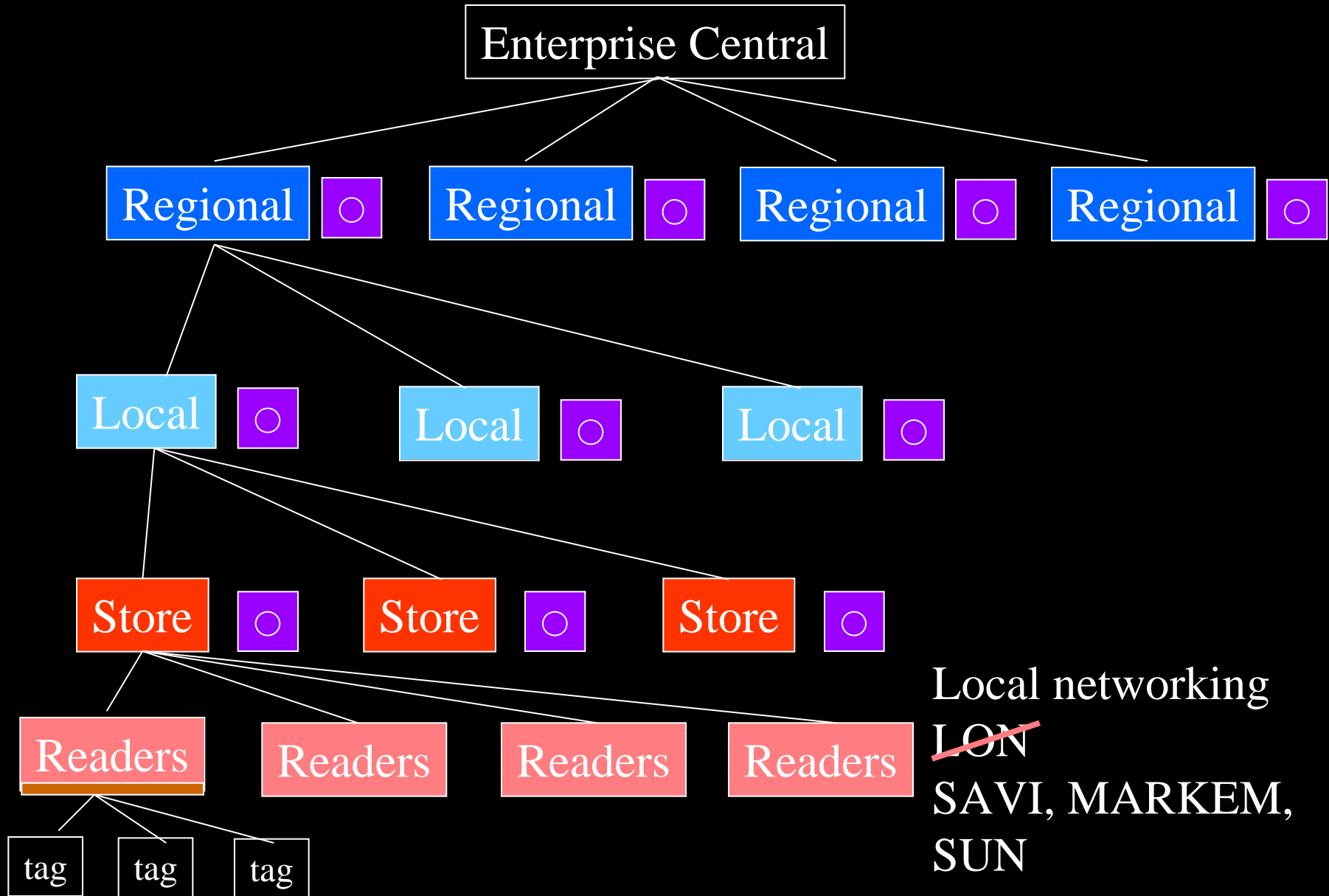
- **A translation format string**
  - **Example: 4.4.4444.1 .1 .1 .3.3.3.01 3 is used to transform a 64-bit ePC 01 1 01 01 001 1 1 1 001 01 1 01 001 1 1 001 01 1 1 1 01 0001 1 01 01 1 0001 1 01 1 01 01 1 001 00**

```
                  +---+---+-+---+-+---+-+---+-+---+-+-+-+-+-+-+----+----+----+----+-+----+-+-----+
Format String     |0|1|3   |.|3    |.|3    |.|3    |.|1|.|1|.|1|.|4    |4    |4    |4    |.|4    |.|4    |
reversed by label |  |  |   |  |   |  |   |  |   |  |  |  |  |   |     |     |     |  |   |  |   |
                  |  |  |   |  |   |  |   |  |   |  |  |  |  |   |     |     |     |  |   |  |   |
Assigned bits in  |  |0|110|  |101|  |001|  |111|  |0|  |0|  |1|  |0110|1001|1100|1011|  |1101|  |0001 |
the ePC prefix    |  |  |   |  |   |  |   |  |   |  |  |  |  |   |     |     |     |  |   |  |   |
                  |  |  |   |  |   |  |   |  |   |  |  |  |  |   |     |     |     |  |   |  |   |
Reversed ePC      |0|0|6   |.|5    |.|1.  |  |7. |  |0|.|0|.|1|.|6    |9    |C    |B    |.|D    |.|1    |
Domain            |  |  |   |  |   |  |   |  |   |  |  |  |  |   |     |     |     |  |   |  |   |
                  +-+-+---+-+---+-+---+-+---+-+---+-+-+-+-+-+-+----+----+----+----+-+----+-+-----+
```

Electronic Product Code

- **A 64 bit ePC is coming up.**

- **Fits into the continuum of 96 bit ePC's.**

- **Different version (header) number.**

- **For reasons of cost of the chip initially.**

- **Proposal in a few weeks.**

Data Logging Architecture

Enterprise Central

Regional ○   Regional ○   Regional ○   Regional ○

Local ○   Local ○   Local ○

Store ○   Store ○   Store ○

Readers   Readers   Readers   Readers

tag   tag   tag

Local networking
LON
SAVI, MARKEM,
SUN

Tag

- **Cheap Chip Challenge (C3W)**
  - **Cheap Chip Action Group**
  - **Is a 5c tag possible?**
  - **Strawman spec**
  - **UHF, 1 3.56 Tags**
  - **Combined readers**

Current status

- **W3C UHF straw-man spec has been presented.**
  - **This is not a standard**
  - **It is a straw-man interim temporary potential open specification.**
  - **Creators: Alien, MIT, consultants.**

An IC Spec has been proposed

- **UHF**
  (Currently US-Centric baby-step, now being expanded for European compatibility)

- **64 bit expandable to 96 bit.**

- **Classes and layers – can incorporate GTIN.**

- **Light-weight, low-cost.**

- **Cost is most important modulo basic requirements.**

Wish-list (wishy-washy list)

- **A few cents (numbers necessary for final target.)**
- **3-5 m clear air range**
- **Read-rate in the 10's per second**

Basic concepts

- **Reader–tag**
  - **Pulse clocking and PWM signaling at 64 KHz**
  - **Mux channels (TDM) down to 8 KHz**
  - **Tag runs at 8 KHz.**
- **Tag–Reader**
  - **BPSK**
  - **32 KHz**
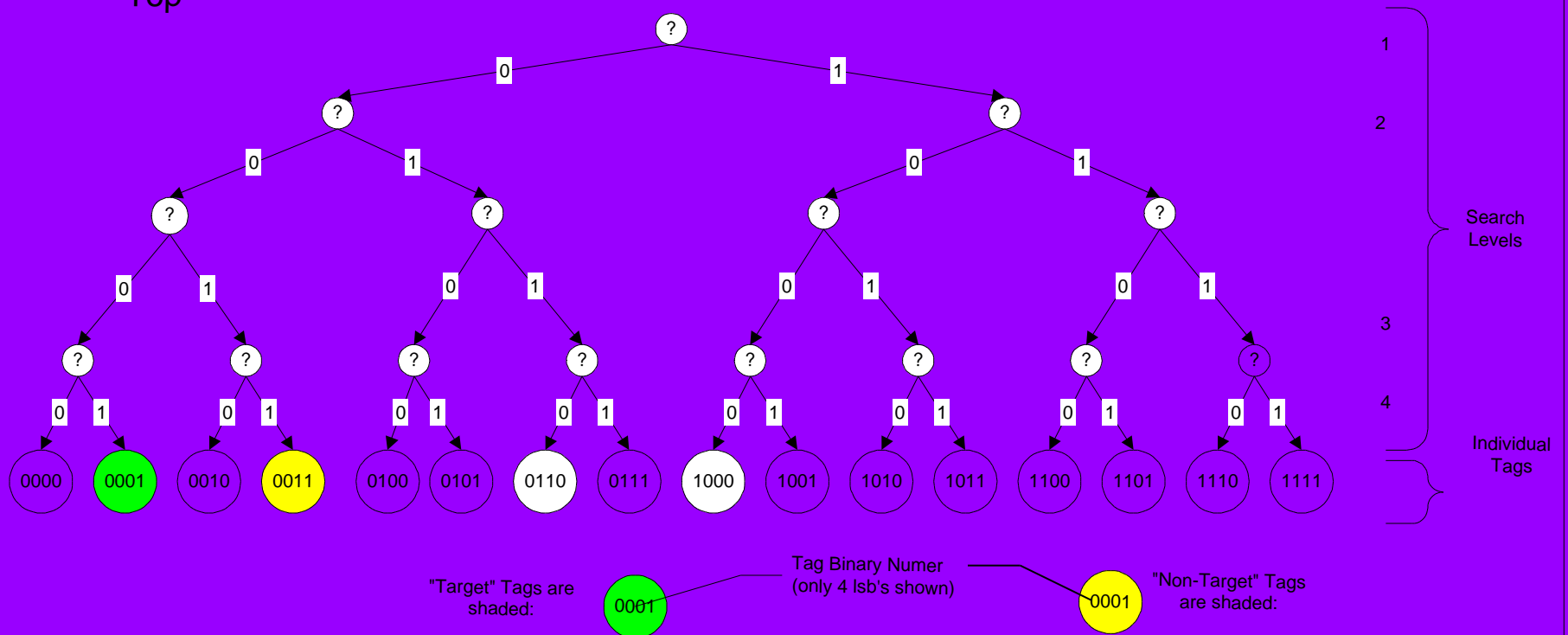- **Quick binary tree anti–collision**

FIGURE 1 – Channelization Timing Diagram

June 3, 2001

Start

Single Tag Search

Step 1

Reset to
Top

1

2

Search
Levels

3

4

Individual
Tags

0000 0001 0010 0011 0100 0101 0110 0111 1000 1001 1010 1011 1100 1101 1110 1111

"Target" Tags are
shaded:

0001

Tag Binary Numer
(only 4 lsb's shown)

0001

"Non-Target" Tags
are shaded:
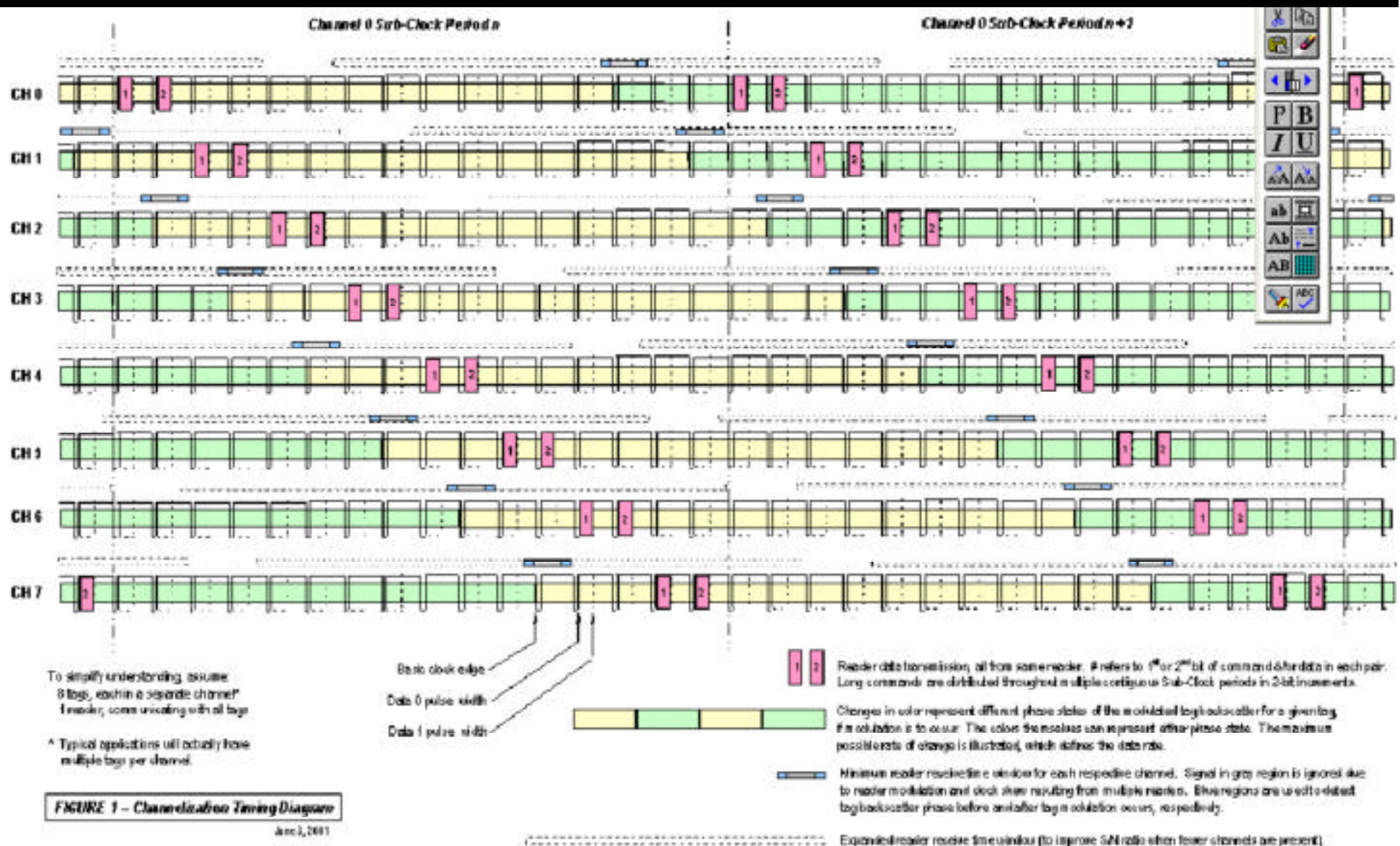
Step 2

Single Tag Search

Step 2

Search 0

1

2

Search
Levels

3

4

Individual
Tags

0000   0001   0010   0011   0100   0101   0110   0111   1000   1001   1010   1011   1100   1101   1110   1111

Here!   Here!

"Target" Tags are
shaded:

Tag Binary Numer
(only 4 lsb's shown)
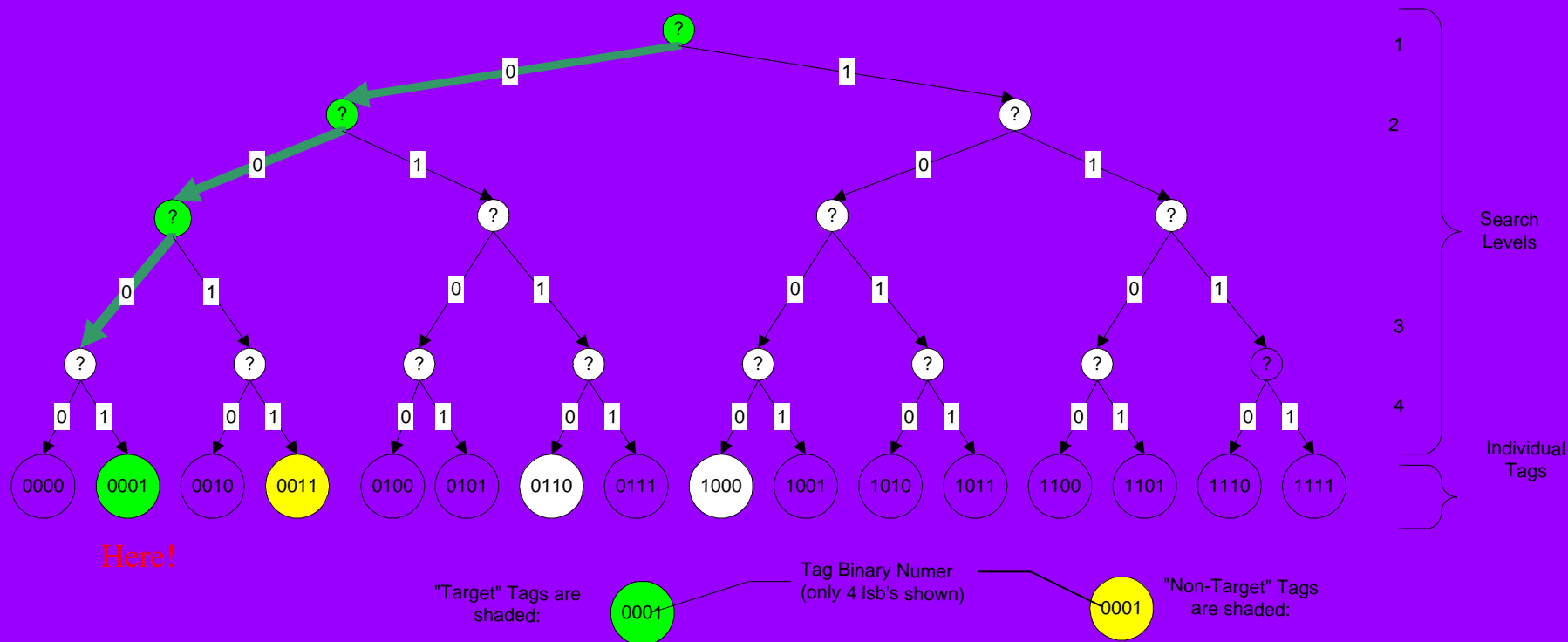
"Non-Target" Tags
are shaded:

0001

0001
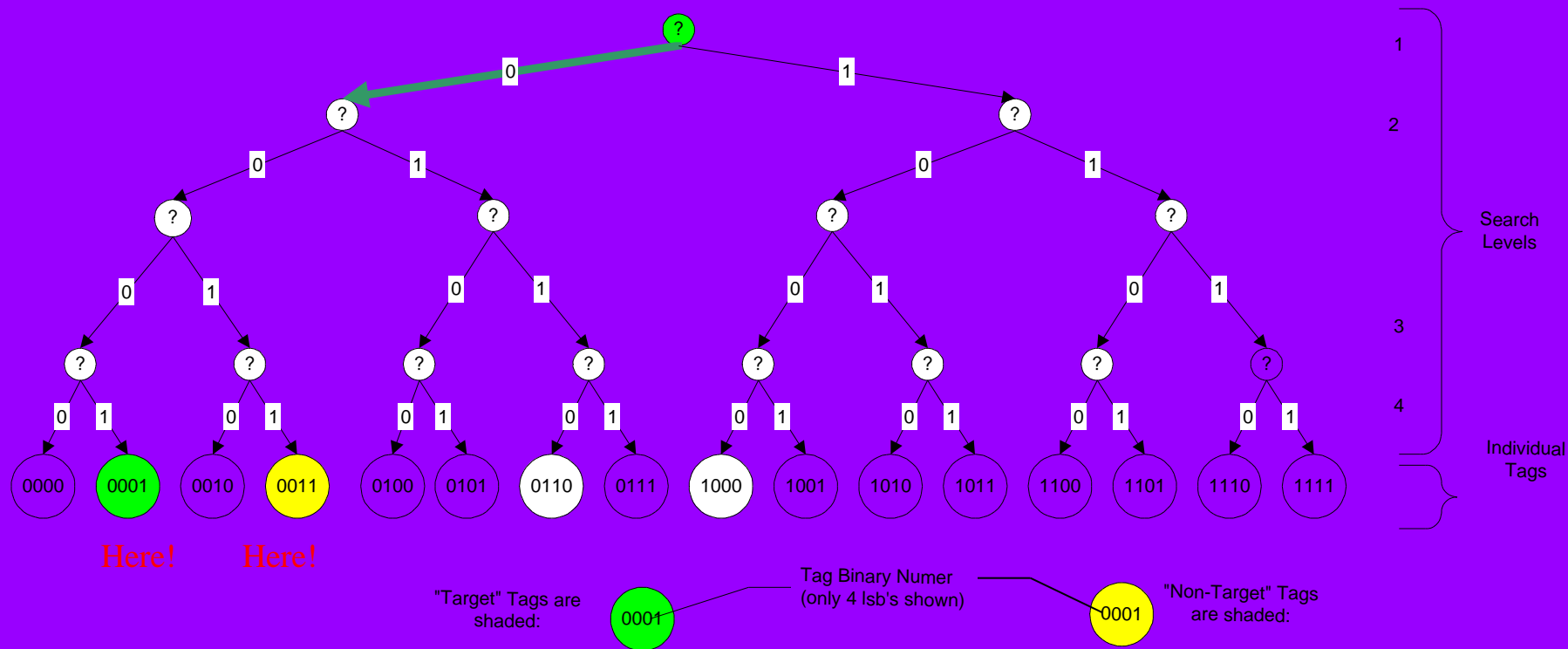
Step 3

Single Tag Search

Step 3

Search 0
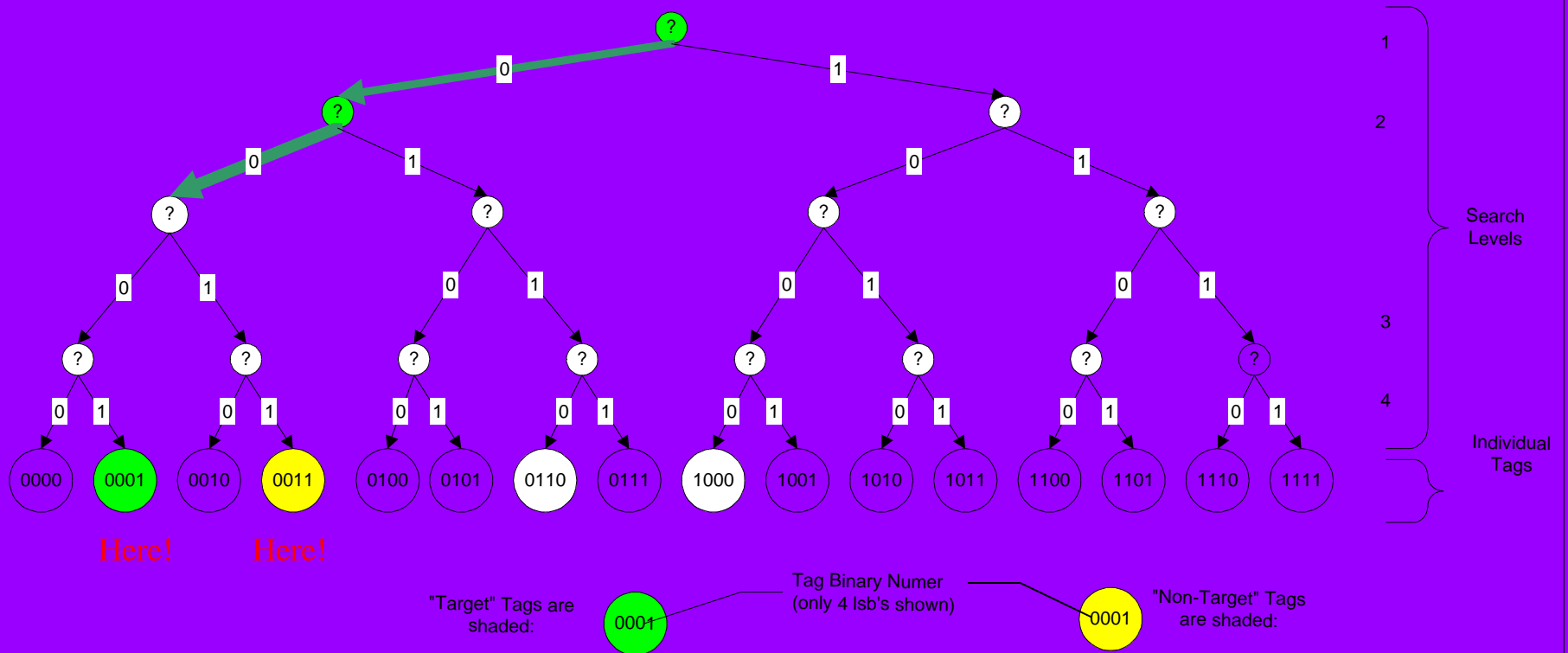
Step 4
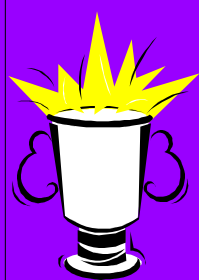
Single Tag Search

Step 4

Search 0

1

2

Search
Levels

3

4

Individual
Tags

0000 **0001** 0010 **0011** 0100 0101 0110 0111 1000 1001 1010 1011 1100 1101 1110 1111

Here!

"Target" Tags are
shaded:

Tag Binary Numer
(only 4 lsb's shown)

0001

0001

"Non-Target" Tags
are shaded:

Step 5

Single Tag Search

Step 5

Search 0

Search Levels

Individual Tags

"Target" Tags are shaded:

0001

Tag Binary Numer (only 4 lsb's shown)

0001

"Non-Target" Tags are shaded:
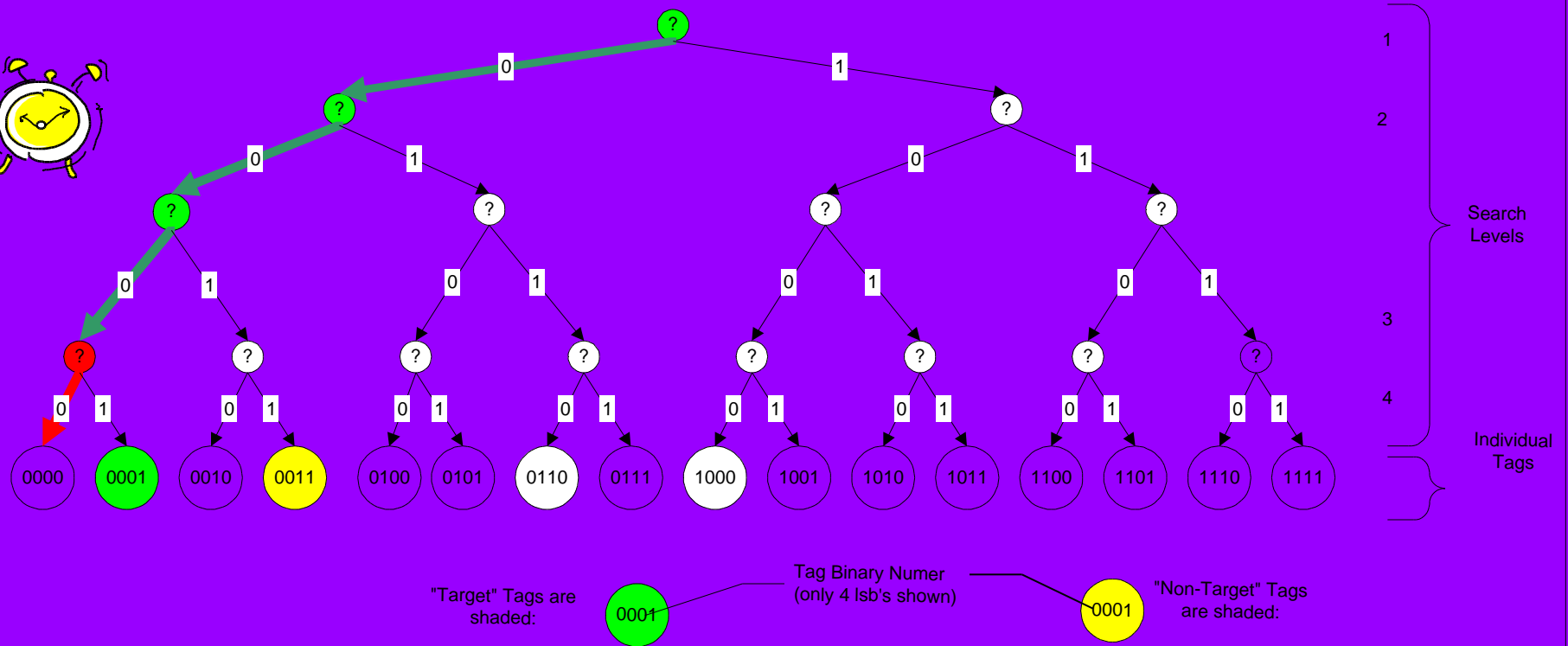
Step 6

Single Tag Search

Step 6

Toggle Down

Here!

"Target" Tags are shaded:

Tag Binary Numer
(only 4 lsb's shown)

"Non-Target" Tags
are shaded:
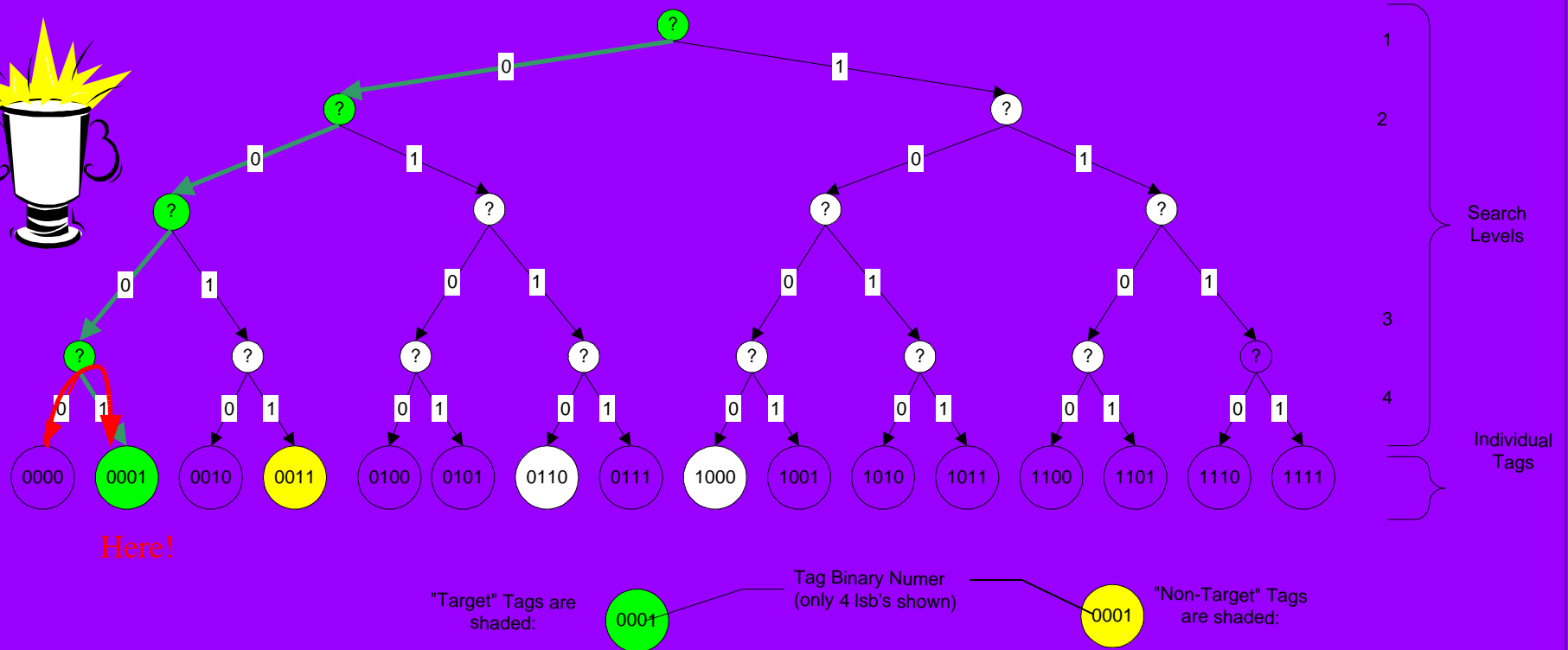
For privacy: One word

- **Annihilate**
- **(obliterate, destroy, auto-destruct, kill, ...)**

Status

- **The C3G has proposed the UHF spec**
- **Open to sponsors**
- **A presentation to experts group on June 11**
- **Feedback being incorporated**
  - **Europe (We also need to continue to lobby).**
  - **Health**
  - **....**

- **Alien to prototype**

Next for C3G

- **C3G1 3.56 & 1 25**
- **Please help us – take the lead (Philips has offered to lead.)**
- **Philosophy is to keep layers.**

The philosophical underpinning

The application layer

The communications layer

125KHz   he RF layer
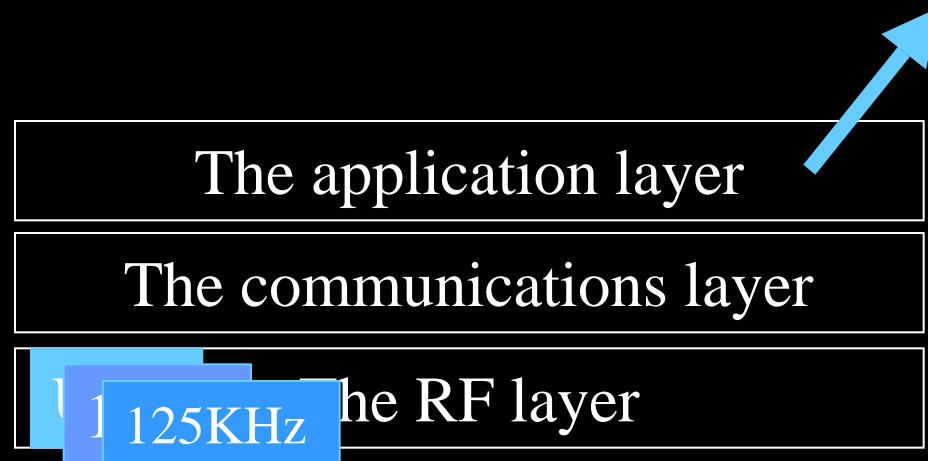
- **Eventually a transport layer for low-level communications?**

The Reader

- **We are still gunning for the multi-frequency, multi-protocol.**
- **ThingMagic, Alien & Co., others interested.**
- **Philips is interested.**

Networking

- **LON project failed.**

- **SAVI ethernet**
- **Wireless networking**
- **Ethernet on a chip solution.**

Personnel

- **Several graduates**
  - **Ashutosh Somani (Mr. PML)**
  - **Paritosh Somani (Mr. Tracking)**
  - **Amar Mehta (Mr. Bluetooth)**

- **Professor Peter Cole. We are trying to snare him.**