

One Laptop Per Child



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V.P. of Software
One Laptop per Child
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Sometimes the riskiest path is
the status quo.



The mission



to develop a low-cost laptop — a technology that could revolutionize how we educate the world's children

A young boy with dark hair is peering through a window. The window is set in a light-colored wall. Outside the window, there is a bright, sunny outdoor area with a wooden fence and some foliage. The boy's face is partially visible through the window frame.

Who?

**The 1.5 billion children
in the developing world**

Presumptions

1



- Schools
 - classrooms
 - electricity
 - teachers
 - books
- Teachers
 - motivated
 - experienced
 - valued by society
 - well educated
- Home
 - electricity
 - space to study
- Parents
 - literate
 - aware of the world
 - want the best for their children
- *Most of these presumptions are wrong*

Children lack opportunity, not capability

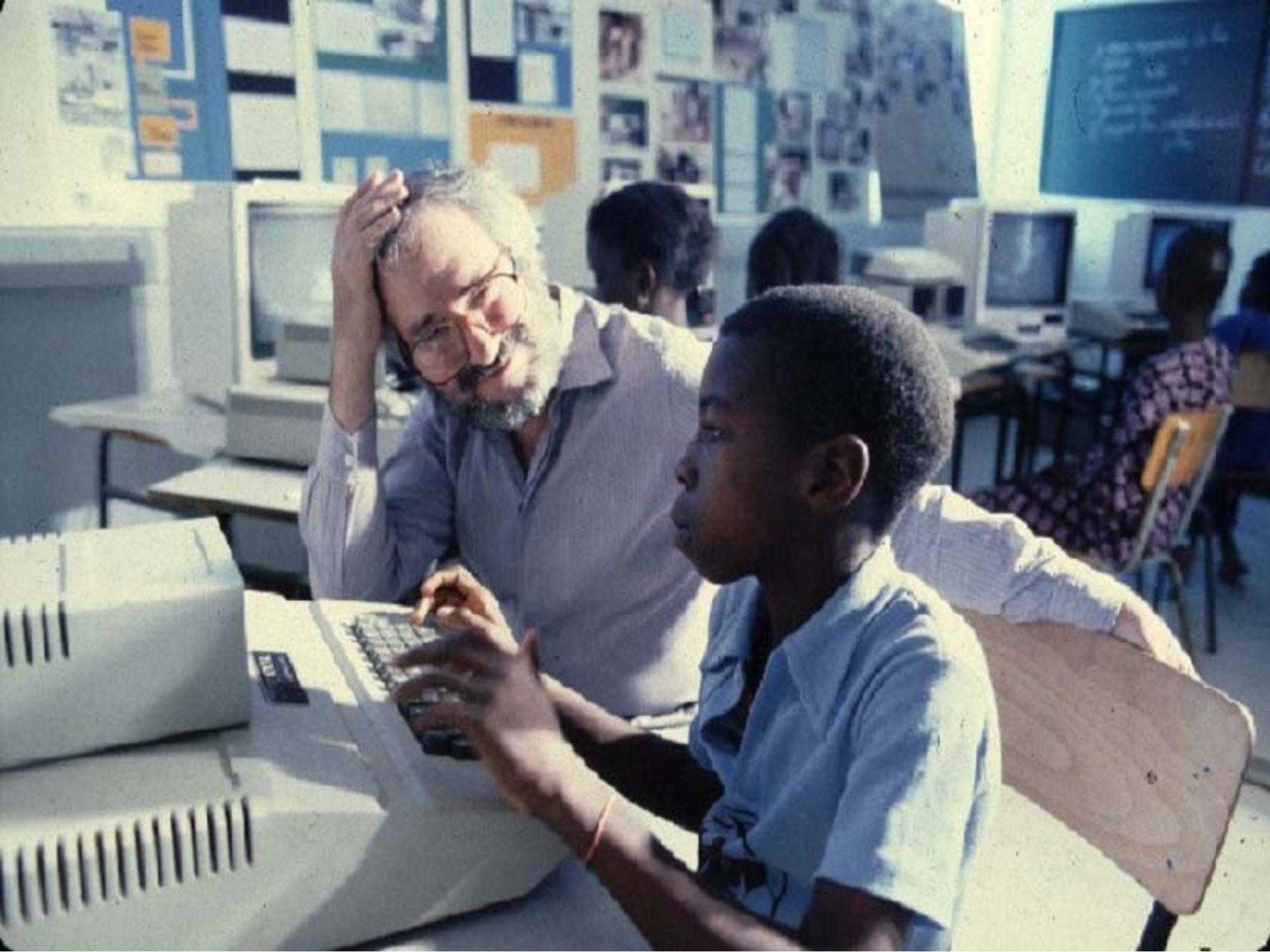


High-quality education *for all* is essential to provide a fair, equitable, economically and viable society; access to laptops—*on a sufficient scale*—provides real benefits for learning.

The Children



- Are just as able to learn as our children
- May have no place to learn, except under a tree or out of doors
 - Most laptops are useless in these environments
- May not even have a school or teacher
- Most children have no electricity at home



Schools



- May not exist
- If they do: insufficient classrooms
 - Many children taught out of doors
 - Makeshift quarters, or none at all
 - Often very crowded – cables in the classroom don't work: must have swappable batteries with bulk chargers
- Two shifts/day in a school, even in better off countries
 - fewer hours in school/day

Our World



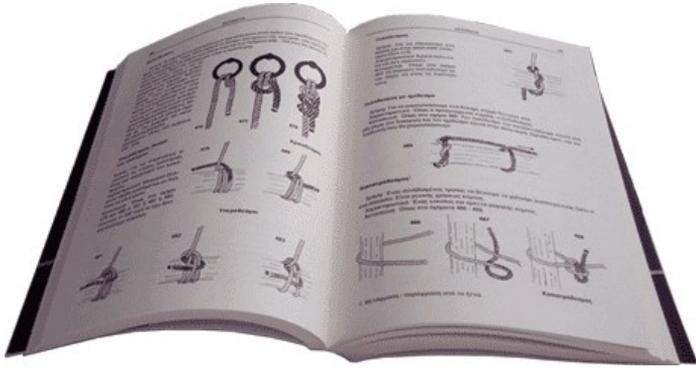


Children at a FCT school in Jahi

Sunlight-readable display



Book Replacement..



- Average book diagonal 8"
- 200 dpi 6 bit per pixel (equivalent to text)
- Reflective and transmissive
 - Black and white in reflection
 - Color with the backlight on (slightly lower resolution)
 - Room light increases resolution
- Ebook mode
 - >13 hours b&w
 - >8 hours color

Parents



- Literacy

- Examples: Uruguay, 98%; Peru, 87%; Uganda, 70%; Haiti, 52%; Pakistan, 50%; Ethiopia, 42%; Afghanistan, 28%
- Significantly lower literacy for girls than boys
 - much lower literacy in rural areas
- Is there even a written form of their language?
 - has anyone invented computer terminology?
- Not computer “literate”

- Experience

- “What is the Internet?”

Teachers



- Often have only 5-6 years of schooling themselves
- Teaching is often very undesirable job: very remote school locations
 - One laptop/teacher
 - Often shared among schools
 - May only be available part time
- What do you do about drop outs?
 - give up?
 - enable learning at other times?

Arahuay, Peru



- End of the road, 2300 meters in the Andes
 - 450 people; school has 55 children
 - Boarding house to enable children to attend from remote locations
 - Bus once a day: only 4-5 hours travel from Lima
 - Most children have electric power at home
 - Next town is several hours **walk** from Arahuay
 - Beyond here, power becomes **the** key concern
 - and permeates deployed costs













SAIDA

I.E.E. 2020 ANUAL
SANTIA/POSTOAL

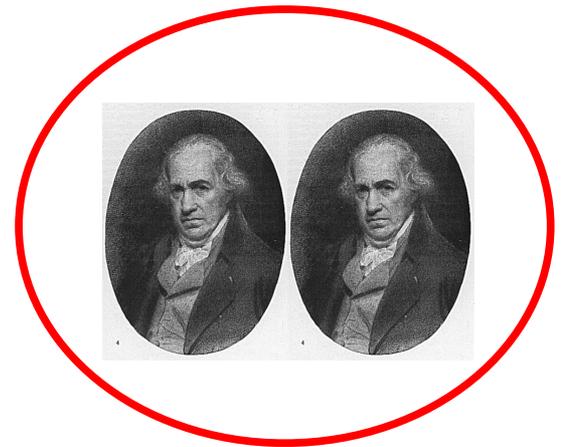








How many Watts?



3-5 Watts Not Good Enough



- A small child can generate 5-10 watts
 - Less than we had hoped, for less time
 - How to get to a reasonable return for the effort ratio? 10X has been our goal
- Mesh network demands wireless be ON
 - To forward packets for others
 - If the child is not confident there will be power when needed, they will try to disable the wireless
- The CPU is usually just:
 - refreshing the screen
 - forwarding packets

Necessity is Mother of Invention



- *Turn off the CPU and most of the system: only leave wireless and possibly display*
- DCON chip allows autonomous display
 - We can take over display from CPU using DCON chip and small RAM chip, saving most of the power.
- Marvell wireless operates autonomously
 - Outboard ARM core, with 192 Kbytes RAM
- Results for ebook reading: 1.5-2.5 watts, depending on screen and wireless use
 - 20 watt hour battery should have good life

Nicholas' School



- 8 hours on rutted 4 wheel drive road
- Electricity – none, except generator @ school
 - conventional laptops: fuel largest expense of school
 - screen is the brightest light at home

“Three Cups of Tea”



- Baltistan, Pakistan (K2 Region)
 - several days travel
 - further up the valleys you go, the less remains from the central government
 - how do you avoid theft in transit?
- Schools of any sort usually lacking
- Regional library: ~200 volumes....
- Children learn 4-5 languages by end of school
Balti, Arabic, English, Pashto, Dari, Farsi

Security & Safety

1



- Activation at Destination
 - Reduce theft in channel, by making systems pretty roof tiles until activated
 - Desirable in many parts of the world
 - From port of entry to final destination
- Anti-Theft
 - Anti-theft leases: needed in some areas
 - Social pressure also very useful, when feasible

Rugged



- Must survive a child being in a rainstorm or dust storm walking to/from school
 - No fans, seal it as best we can
 - Lower power would avoid convective cooling
 - Is this good enough? Only time will tell
- Conventional server hardware poor
 - too much power
 - not sealed – fans not acceptable
 - corrosion: warm salt air near ocean is the worst
- Repair depots are days, weeks, or months away

Accidents Happen....



Surprise!



- Really remote – Amazonian Peru
 - *20 days travel time* for a teacher to go to a school
 - by road, canoe, foot...
 - teachers travel one month, teach one month, and travel back one month
 - Think about cost of power: even at Nicholas' school, fuel for a generator is the largest operating expense with conventional laptops!
 - Now think 20 days by boat, horse, foot
 - Books very scarce: 1 laptop hard-drive == MANY books

Field Repair



- Not a luxury, a necessity
 - Despite making a rugged machine, it must also be field repairable, by anyone, with a screwdriver
 - Can't go get parts, can't require experts
- “Laptop hospital”
 - Spare parts
 - Franken-machines
 - Repair by the older kids

How to get power and net?



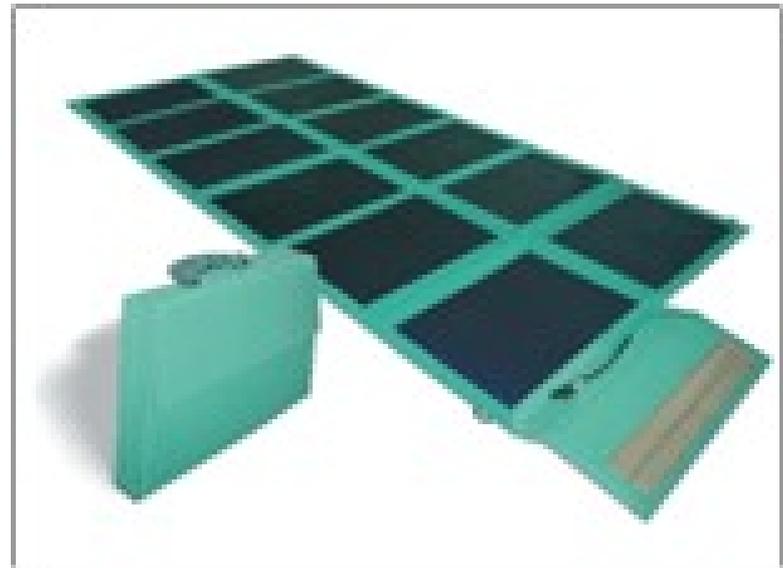
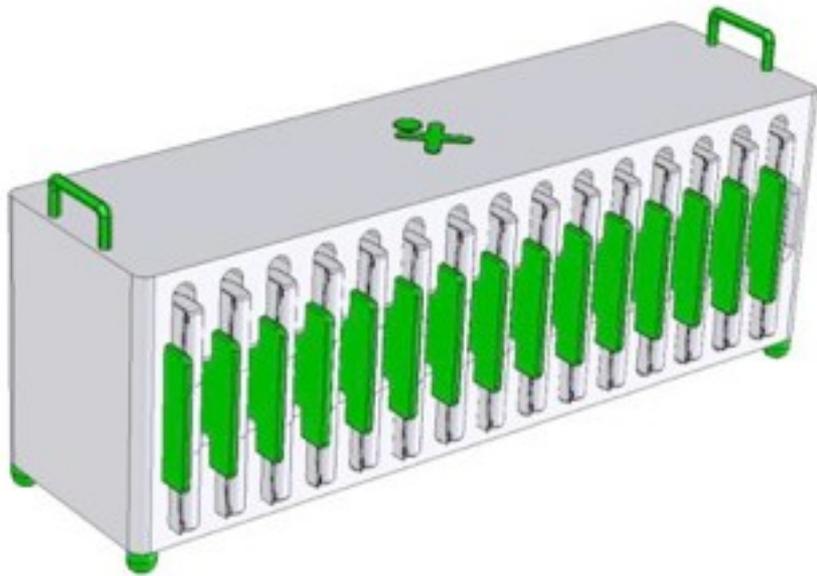
- Mountains are good for network, radio quiet, long line of sight
- Rain forest may not be insurmountable
 - Rain forest trees can be climbed
 - Solar panels up high: need high voltage transmission
 - Interconnect schools to minimize uplinks
 - Downlink via multicast for free for loading caches

Power: whatever we can get



- Indirect costs can easily exceed the laptop cost: power is expensive
- Swappable batteries & bulk charger
- Solar panels - \$12US for 5 Watts
- Solar blankets - \$150US for 60 Watts
- Hand Crank
- Food pedal
- Bicycle
- Cow
- Generator
- Water power
- Wind





Environmental

1



5 years of text books

- * deforestation
- * chemicals to make paper
- * distribution costs

vs



1 laptop

- * RoHS compliant ++
- * 2W power
- * 5 year life (including batteries)
- * 2000 cycle batteries
- * recyclable
- * cleanest laptop ever built

They'll share their learning through networking.

Learning is maximized when ideas are shared and is made part of the everyday social experience. Children (and teachers) should be able to build upon each other's ideas, experience and knowledge.



Connectivity

- Child to child communication is as important as child to teacher and child to Internet
- Wireless / Unlicensed / Build it Yourself
- Bandwidth is a perishable commodity
- We'll take whatever we can get: any connectivity is better than no connectivity





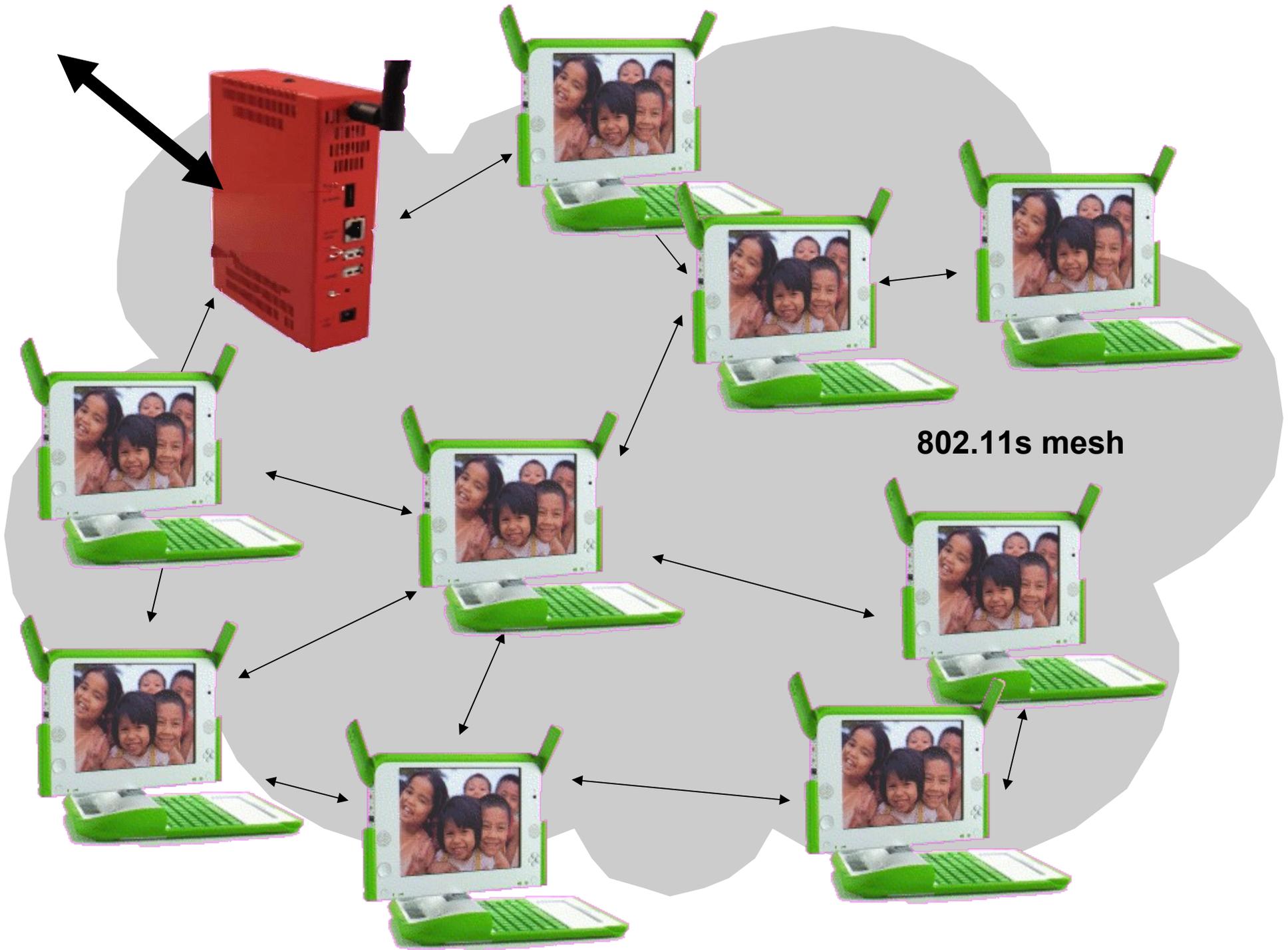
Arahway, Peru



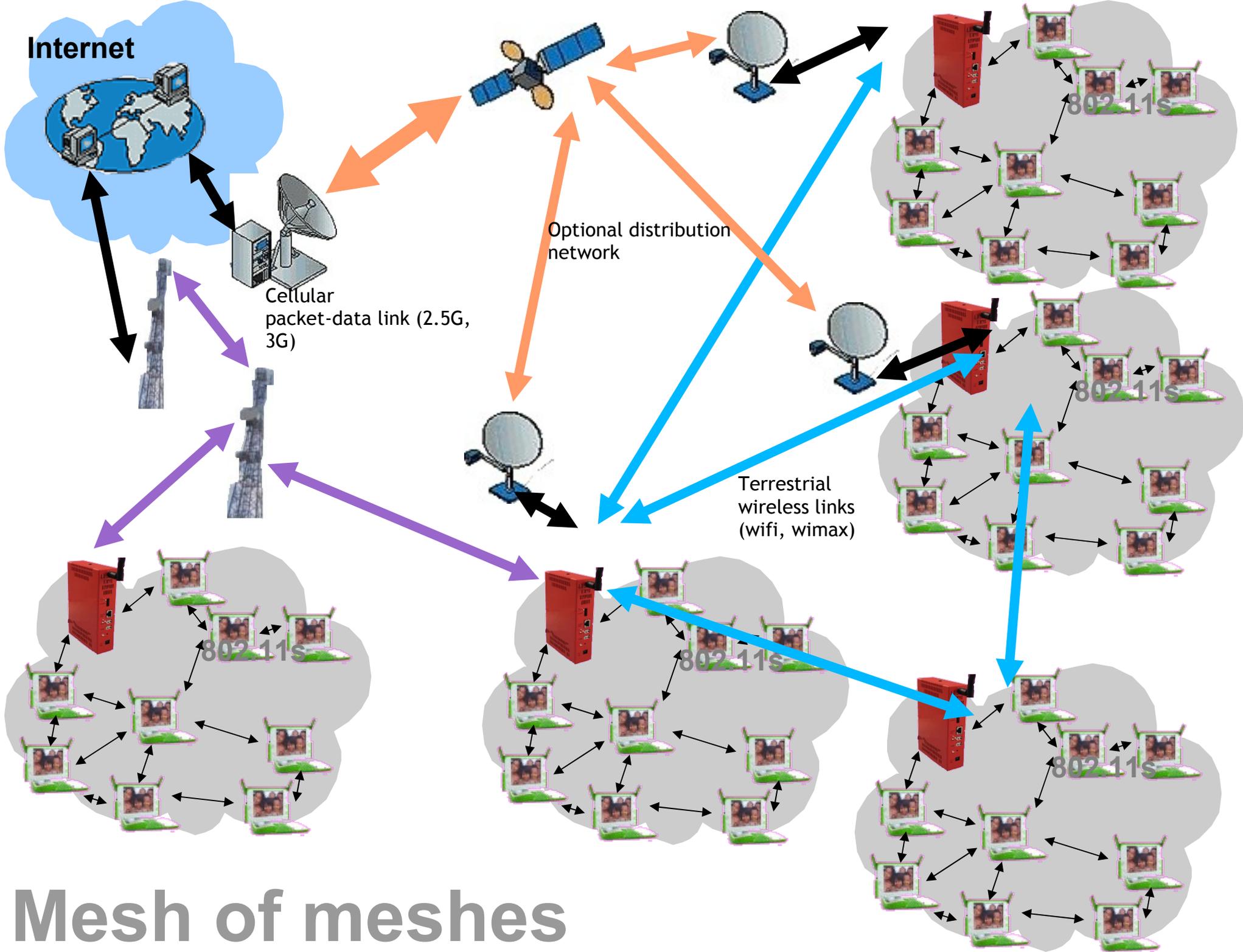
Kashmir



Build it yourself! Athens, Greece



802.11s mesh



Internet

Cellular
packet-data link (2.5G,
3G)

Optional distribution
network

Terrestrial
wireless links
(wifi, wimax)

802.11s

802.11s

802.11s

802.11s

802.11s

Mesh of meshes

Rubber hook provides a variety of attachment /mounting types.

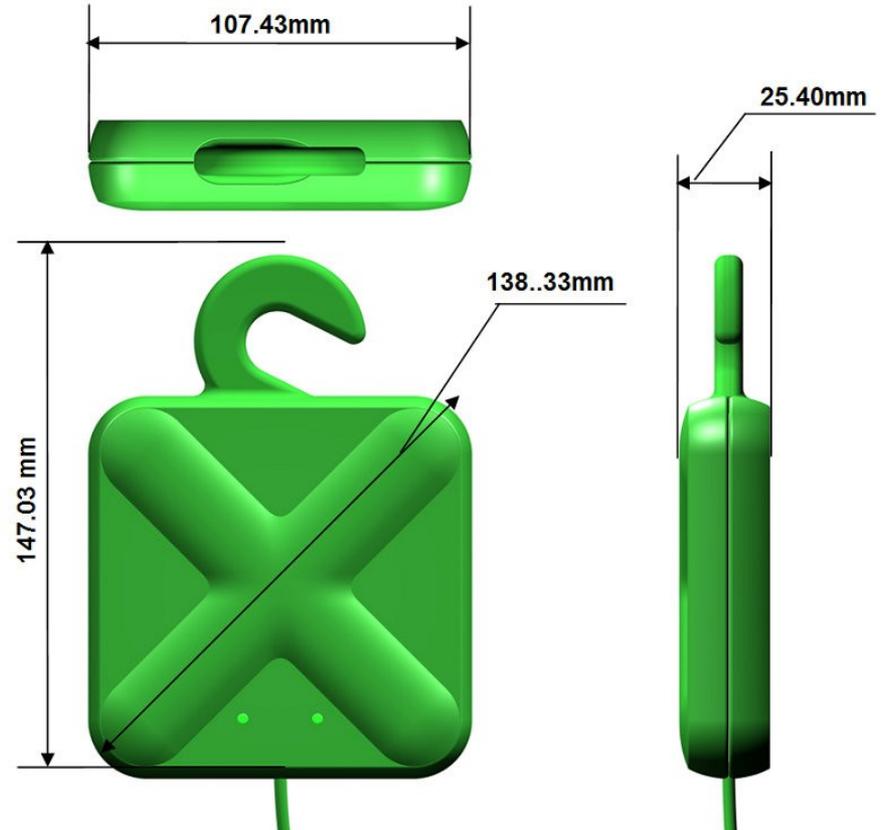
Rubber hook is stepped from the back surface

PCB Board & Antenna Housing

LED Indicator Lights

5 meter USB cord

Camera Thread Mount Location (for tripod mounting)



Learning learning by debugging

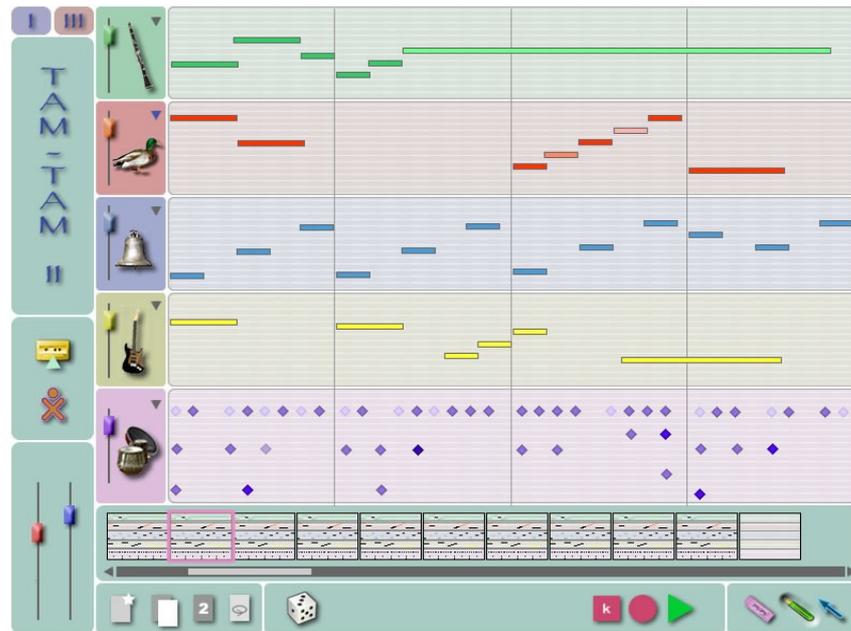


A. Burton

Children will be both consumers *and* creators



&



How do we enable safe sharing of code?



- Children and teachers to be able to exchange and enhance activities
- We don't have unlimited mass storage space – activities must come and go easily
- For more information, see the Bitfrost specification

Sugar

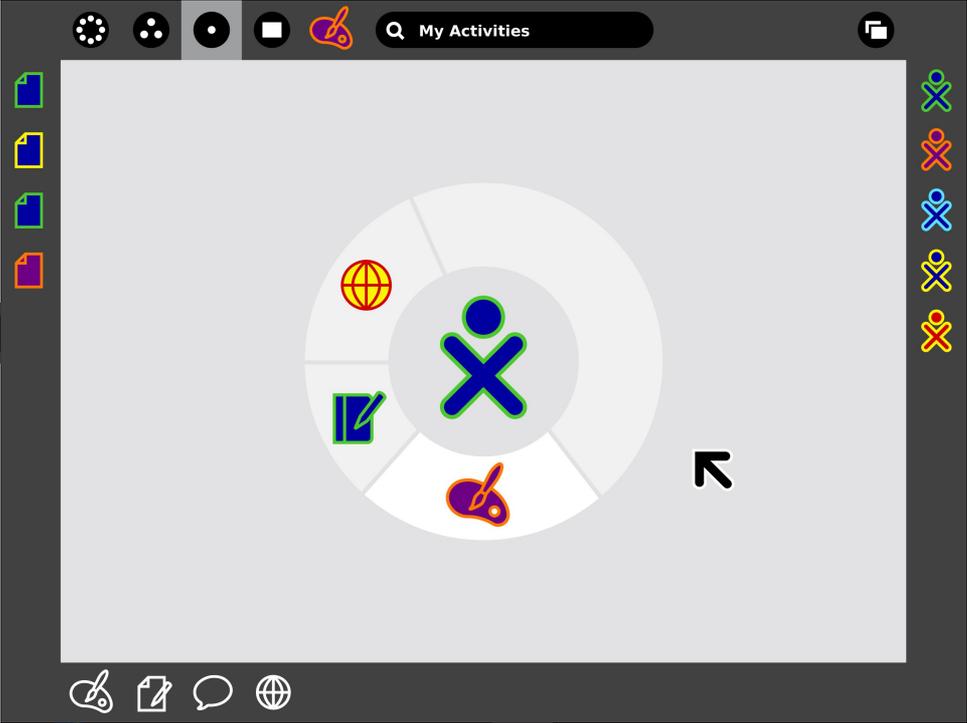


- GTK+/Pango/ATK/Cairo stack
 - The same as gnome, the components are cross platform; applications may or may not be
- Python to tie it all together
 - Conventional applications can be embedded
 - Many of our activities expose themselves at a single “show source” keystroke
- Using Presence as basis:
 - Web – follow me
 - Chat, Voice, Collaborative editing
 - Make music together: TamTam
 - Kids teach kids: teachers guide kids

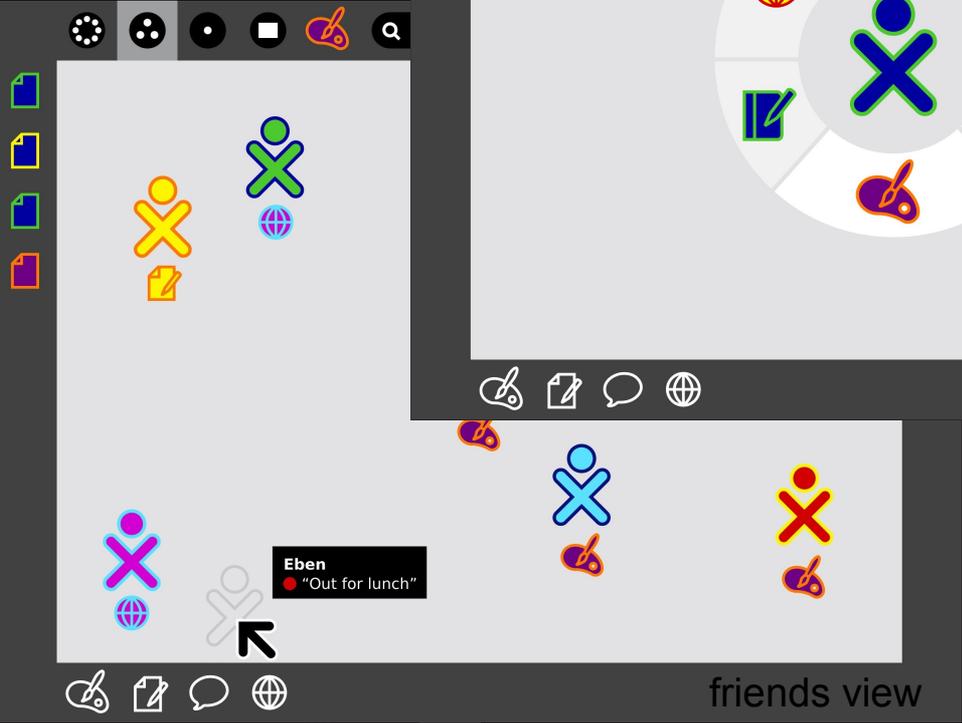
Collaboration, end to end, is key

Zoom Interface

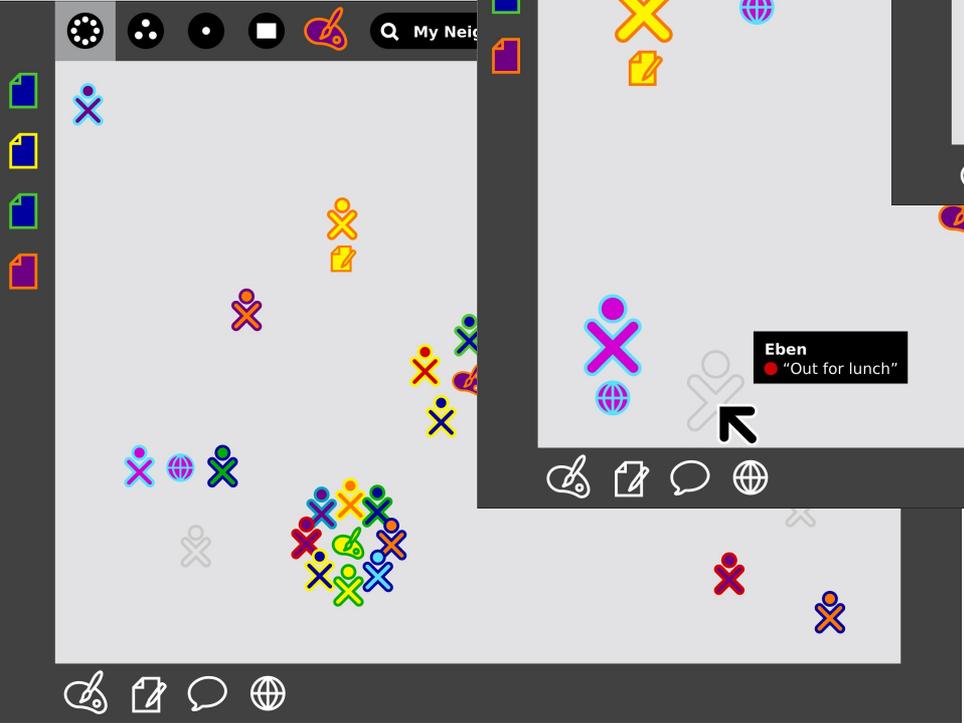
activities view



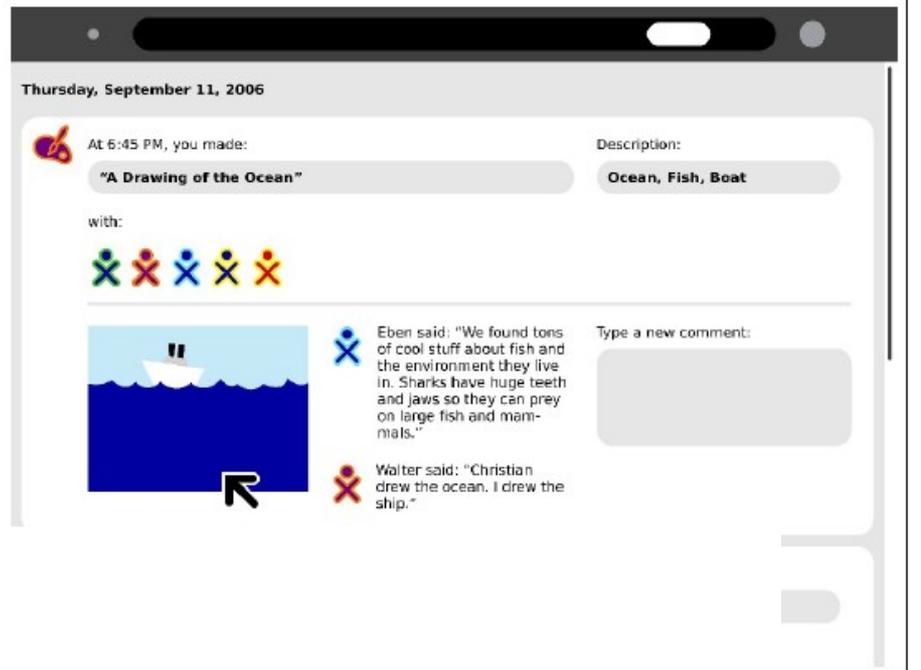
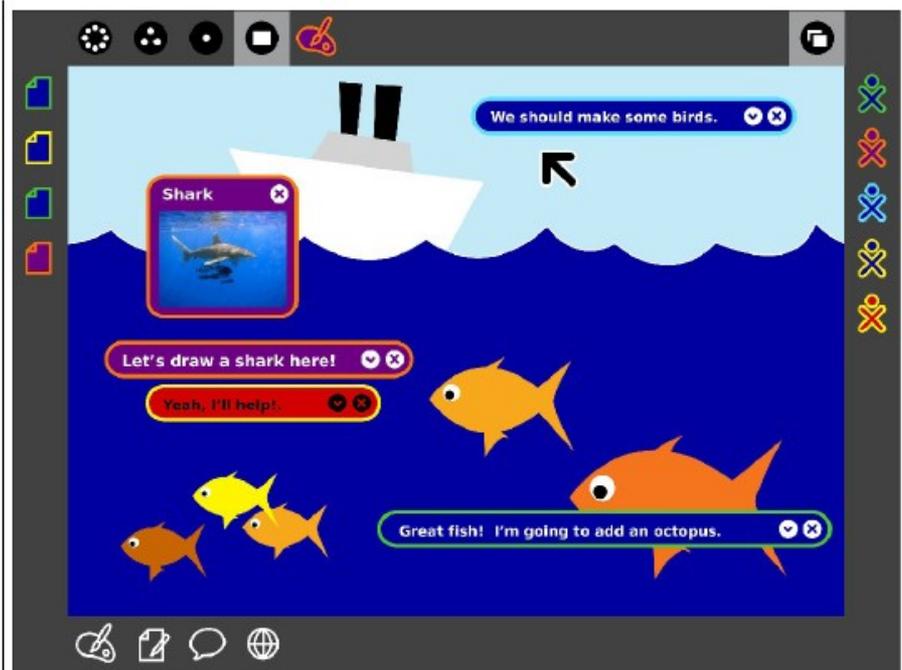
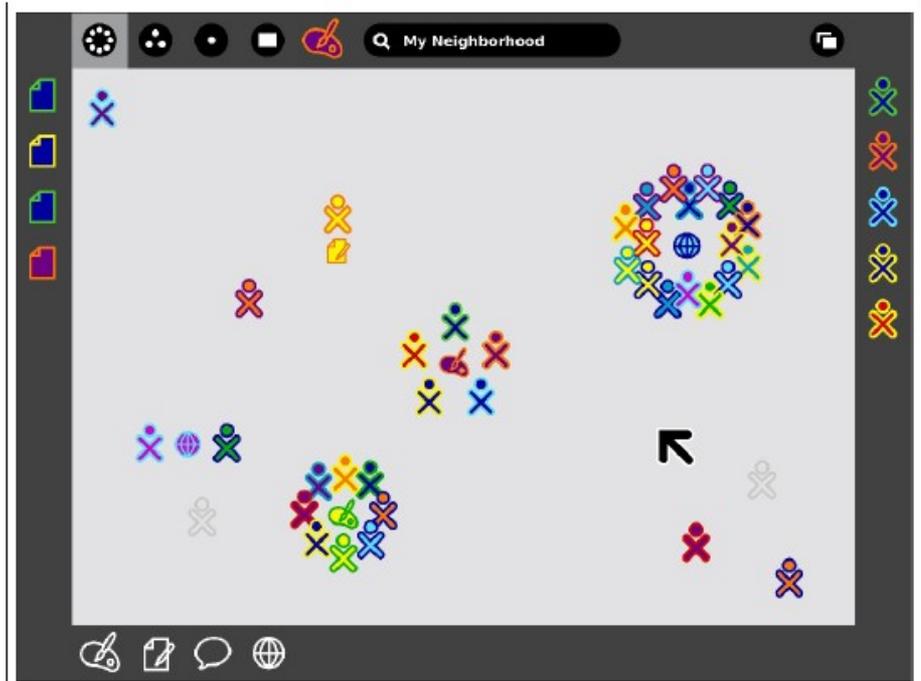
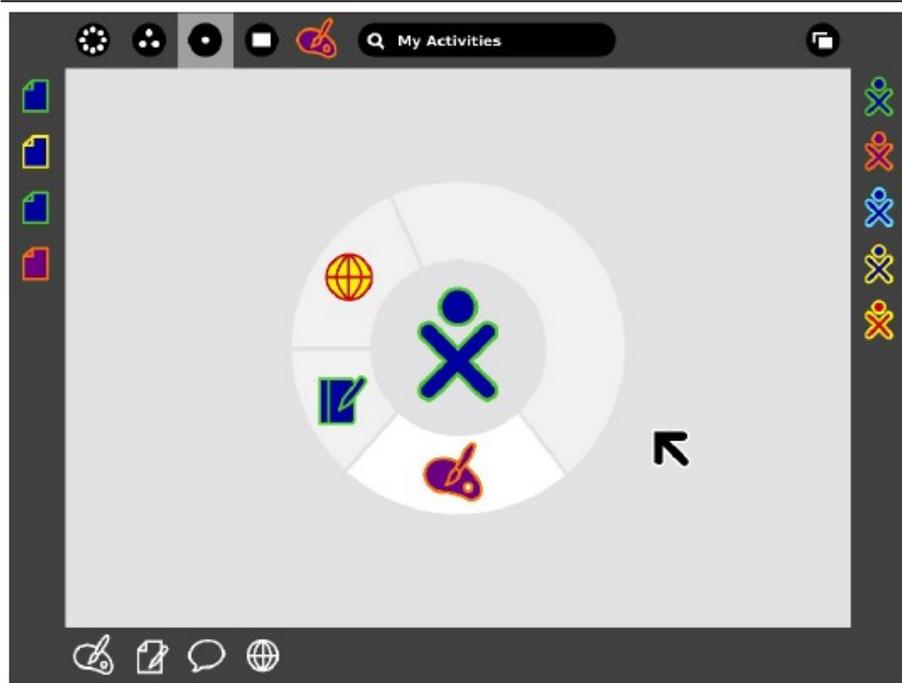
friends view



mesh view



Peer to Peer User Interface



Software Applications



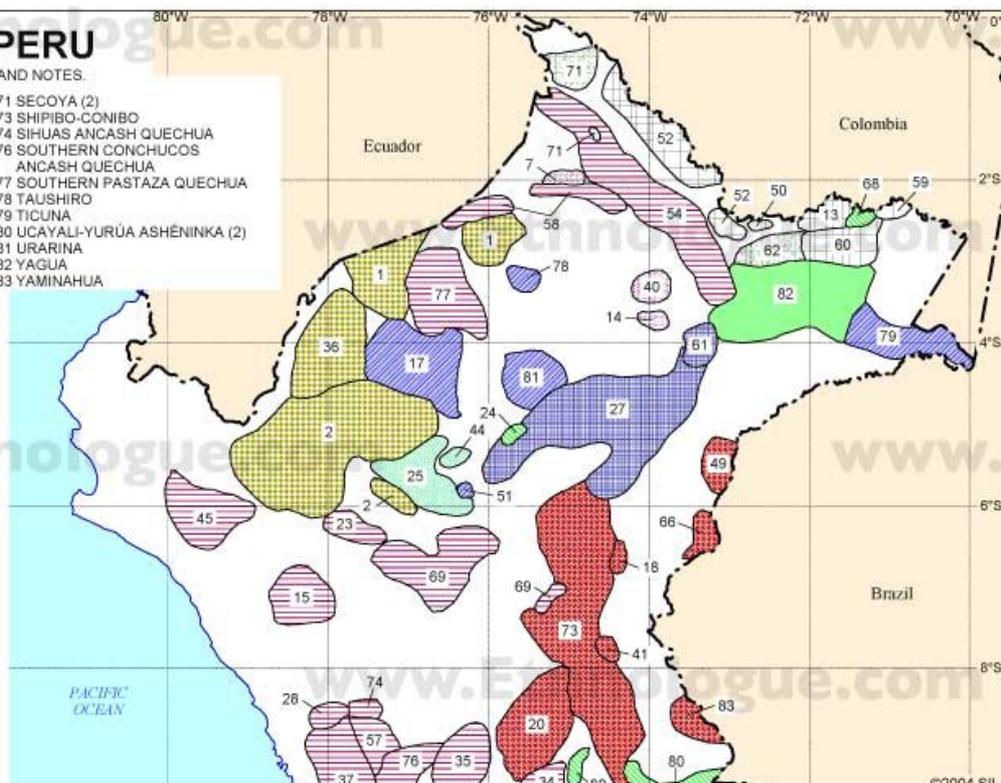
- Journal
- Web browser
- WIKI / WP
- eBook
- Chat
- Measure
- Camera
- RSS News Reader
- Logo (TurtleArt)
- Squeak/EToys
- Video support
- Audio support
- Multimedia
- Pippy
- Paint
- etc....

Collaboration is already integrated into many of these applications

NORTHERN PERU

SEE SOUTHERN PERU MAP FOR KEY AND NOTES.

- | | |
|-----------------------------|--------------------------------|
| 1 ACHUAR-SHIWAR (2) | 71 SECOYA (2) |
| 2 AGUARUNA (2) | 73 SHIPIBO-CONIBO |
| 7 ARABELA | 74 SIHUAS ANCASH QUECHUA |
| 13 BORA | 76 SOUTHERN CONCHUCOS |
| 14 CAHUARANO | ANCASH QUECHUA |
| 15 CAJAMARCA QUECHUA | 77 SOUTHERN PASTAZA QUECHUA |
| 17 CANDOSHI-SHAPRA | 78 TAUSHIRO |
| 18 CAPANAHUA | 79 TICUNA |
| 20 CASHIBO-CACATAIBO | 80 UCAYALI-YURUÁ ASHÉNINKA (2) |
| 23 CHACHAPOYAS QUECHUA | 81 URARINA |
| 24 CHAMICURO | 82 YAGUA |
| 25 CHAYAHUITA | 83 YAMINAHUA |
| 27 COCAMA-COCAMILLA | |
| 28 CORONGO ANCASH QUECHUA | |
| 34 HUALLAGA HUÁNUCO QUECHUA | |
| 35 HUAMALIES-DOS DE MAYO | |
| HUÁNUCO QUECHUA | |
| 36 HUAMBISA | |
| 37 HUAYLAS ANCASH QUECHUA | |
| 40 IQUITO | |
| 41 ISCONAHUA | |
| 44 JEBERO | |
| 45 LAMBAYEQUE QUECHUA | |
| 49 MATSES | |
| 50 MINICA HUITOTO | |
| 51 MUNICHE | |
| 52 MURUI HUITOTO (2) | |
| 54 NAPO LOWLAND QUICHUA | |
| 57 NORTHERN CONCHUCOS | |
| ANCASH QUECHUA | |
| 58 NORTHERN PASTAZA QUICHUA | |
| 59 NÚPODE HUITOTO | |
| 60 OCAINA | |
| 61 OMAGUA | |
| 62 DREJÓN | |
| 66 PISABO | |
| 68 RESIGARO | |
| 69 SAN MARTÍN QUECHUA (2) | |



- 350 languages of > 1 million speakers
- Spanish, Quechua, Aymara

SOUTHERN PERU

NATIONAL LANGUAGES

CUSCO QUECHUA SPANISH

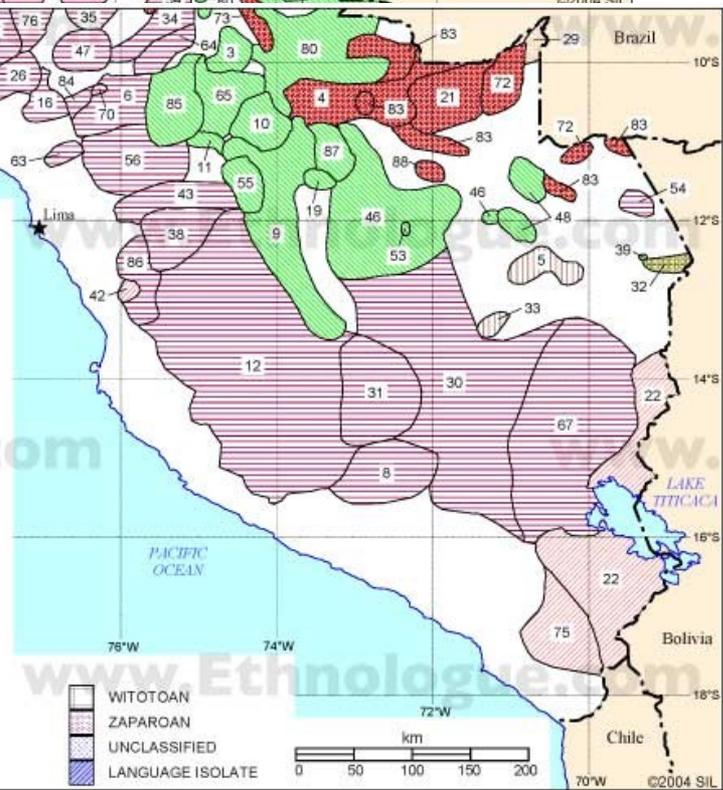
NOTES:

1. DASHED LINES SHOW OVERLAP OF LANGUAGE AREAS.
2. BRACKETS SHOW THE NUMBER OF TIMES A LANGUAGE'S NUMBER APPEARS ON MAP, IF MORE THAN ONCE.

- | | |
|-----------------------------|--------------------------------|
| 3 AJYÍNINKA APURUCAYALI | 43 JAUJA WANCA QUECHUA |
| 4 AMAHUACA | 46 MACHIGUENGA (2) |
| 5 AMARAKAERI | 47 MARGOS-YAROWILCA-LAURICOCHA |
| 6 AMBO-PASCO QUECHUA | QUECHUA |
| 8 AREQUIPA-LA UNIÓN QUECHUA | 48 MASHCO PIRO |
| 9 ASHANINKA | 53 NANTI |
| 10 ASHENINKA PAJONAL | 54 NAPO LOWLAND QUECHUA |
| 11 ASHENINKA PERENE | 55 NOMATSIGUENGA |
| 12 AYACUCHO QUECHUA | 56 NORTH JUNÍN QUECHUA |
| 16 CAJATAMBO NORTH LIMA | 63 PACARAOS QUECHUA |
| QUECHUA | 64 PANAO HUÁNUCO QUECHUA |
| 19 CAQUINTE | 65 PICHIS ASHÉNINKA |
| 21 CASHINAHUA | 67 PUNO QUECHUA |
| 22 CENTRAL AYMARA (2) | 70 SANTA ANA DE TUSI PASCO |
| 26 CHIQUIÁN ANCASH QUECHUA | QUECHUA |
| 29 CULINA | 72 SHARANAHUA (2) |
| 30 CUSCO QUECHUA | 73 SHIPIBO-CONIBO |
| 31 EASTERN APURIMAC QUECHUA | 75 SOUTHERN AYMARA |
| 32 ESE EJA | 76 SOUTHERN CONCHUCOS |
| 33 HUACHIPAERI | ANCASH QUECHUA |
| 34 HUALLAGA HUÁNUCO QUECHUA | 80 UCAYALI-YURUÁ ASHÉNINKA |
| 35 HUAMALIES-DOS DE | 83 YAMINAHUA (5) |
| MAYO HUÁNUCO QUECHUA | 84 YANAHUANCA PASCO QUECHUA |
| 37 HUAYLAS ANCASH QUECHUA | 85 YANESHA' |
| 38 HUAYLLA WANCA QUECHUA | 86 YAUYYOS QUECHUA |
| 39 IÑAPARI | 87 YINE |
| 42 JAQARU | 88 YORA |

LANGUAGE FAMILIES

- | | | | | | | | | | | | | | | | |
|--------|----------|---------|------------|-----------|----------|--------|-------------|----------|---------|----------|------|----------|----------|--------------|------------------|
| ARAUAN | ARAWAKAN | AYMARAN | CAHUAPANAN | HARAKMBET | JIVAROAN | PANOAN | PEBA-YAGUAN | QUECHUAN | TACANAN | TUCANOAN | TUPI | WITOTOAN | ZAPAROAN | UNCLASSIFIED | LANGUAGE ISOLATE |
|--------|----------|---------|------------|-----------|----------|--------|-------------|----------|---------|----------|------|----------|----------|--------------|------------------|



Source: Ethnologue

Localization



- ~350 languages with > 1 million speakers
- Children may learn as many as 4-5 languages before leaving school in 5th grade
- Current techniques do not scale
- Localization must be able to be added later – cannot coordinate software releases to translations at this scale

Thank You!!!

Without *your* efforts over many years this initiative would not be possible.

With *your* help this initiative *will* succeed.

Questions?

