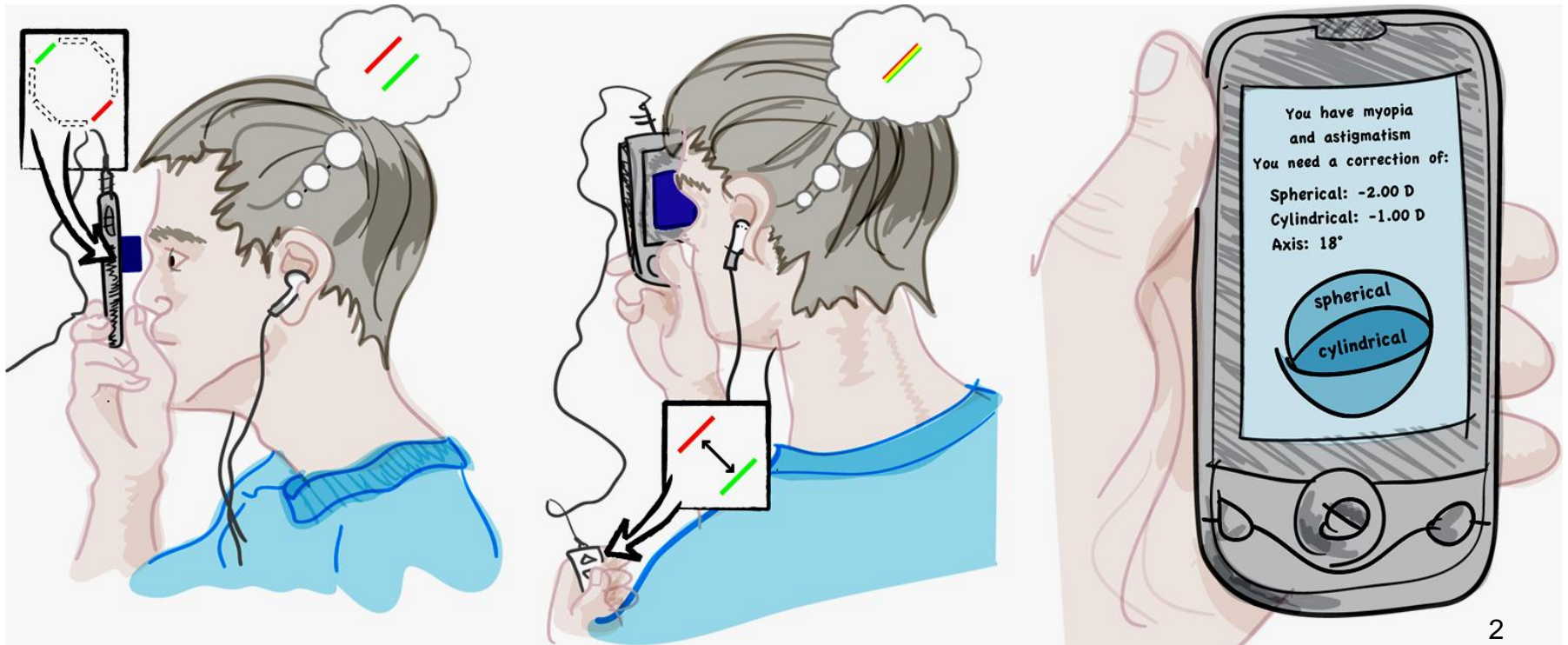


NETRA: Vision Test on a Cellphone

Ramesh Raskar
MIT Media Lab

NETRA: Interactive Display for Estimating Refractive Errors



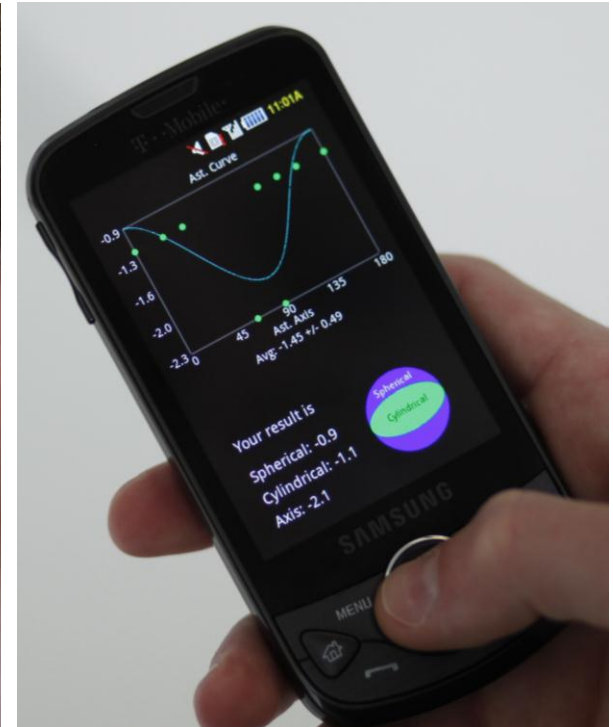
NETRA: Near Eye Tool for Refractive Assessment

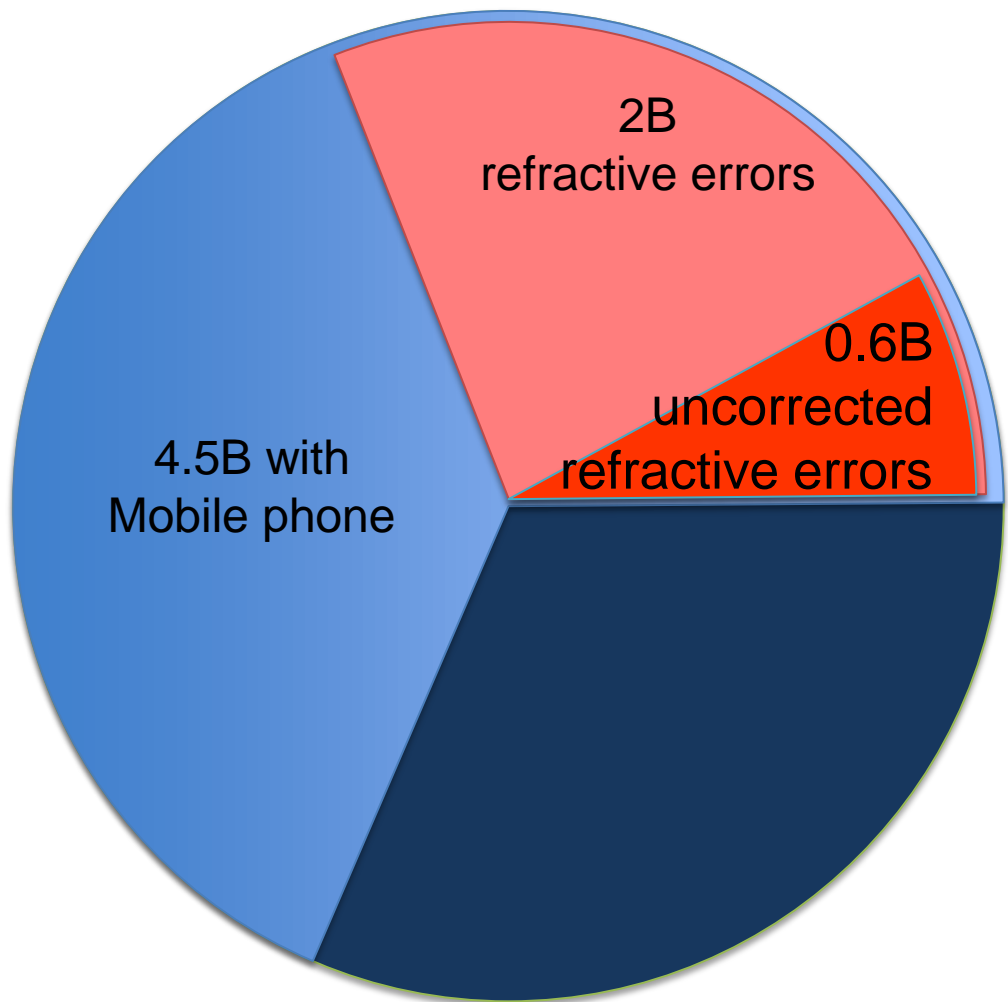
Vitor Pamplona

Ankit Mohan

Manuel Oliveira

Ramesh Raskar





6.5 Billion people



NETRA at
LVP Eye Institute

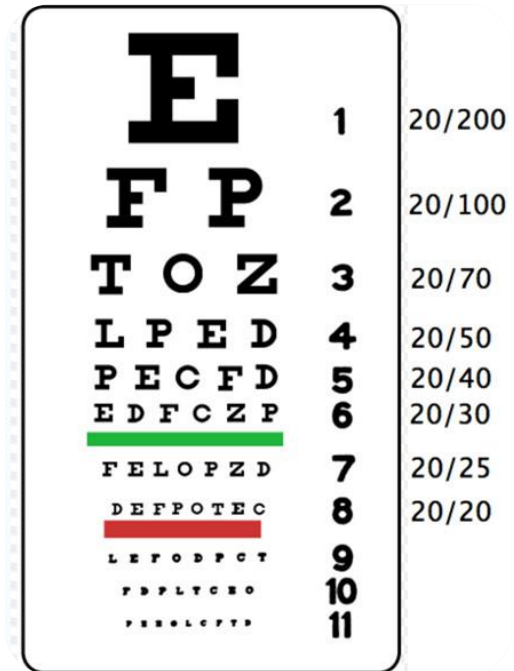
Reading Charts



Phoropter



Trial lenses



- Accuracy
 - Sharpness Estimation is subjective
 - Brightness affects results/pupils size/DoF
- Cost
 - Trial Lens Set > \$150
 - Bulky

Diagnostics



Bulky Equipment or Trained Professionals

Dispensing Glasses



Increasingly cheap and easy

Needs expert, Moving parts, Shining lasers

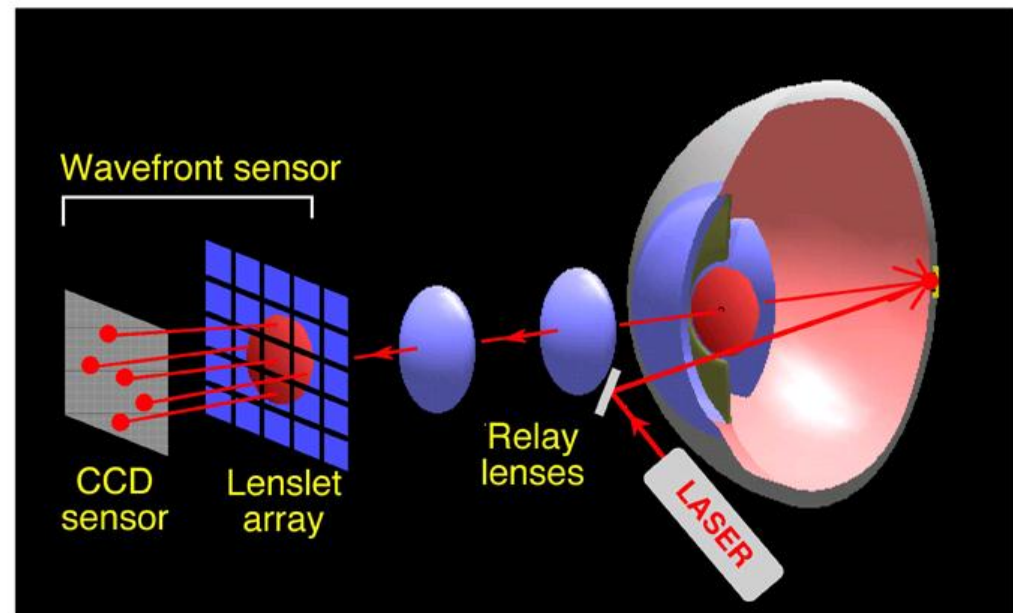
	Retino scope w/ Lenses	Auto- refractometer	Chart with Lenses	In-Focus: Focometer	Optiopia	Solo- health: EyeSite	NETRA
Technology	Shining Light plus lenses	Moving Pupil or Shack- hartmann		Moving lenses + target	Moving lenses + target	Reading chart on monitor	Cellphone + eyepiece
Cost to buy	\$600*	~\$10,000	~\$100	~\$495	~\$200	--	(cellphn)
Cost per test	~\$36	~\$36	~\$5	--	--	--	~\$1
Mobility	<500g	>10Kg	2kg	1kg	<5kg	>10Kg	<100g
Accuracy (D)	0.15	0.15	0.5	0.75	--	--	<0.5
Self evaluation	No	No	Yes	Yes	Yes	Yes	Yes
Astigmatism	Yes	Yes	Yes/No	No	--	--	Yes
Network	No	Yes	No	No	No	Yes	Yes
Electricity Req	No	Yes	No	No	--	Yes	No
Data capture	No	Digital	No	No	No	Digital	Phone
Training	High	Medium	High	Medium	Medium	Low	Low

* Phoropter-based: \$5,000.00

Shack-Hartmann Wavefront Sensor



Wavefront aberrometer



Expensive; Bulky, Requires trained professionals

Limitations

- Children
- Ability to align lines
 - Retina, Animals
- Single Eye test
 - Exploit convergence-forced accommodation
- Requires high resolution display
 - Samsung Behold II – 160 DPI – 0.35D
 - Google Nexus One – 250 DPI – 0.2D
 - Apple iPhone 4G – 326 DPI – 0.14D (30 micrometer pixel)



Status

- Scientific Papers
 - **ACM SIGGRAPH** (top Journal)
 - Frontiers in Optics
 - Am Academy of Optometry (AAO)
- **IP** filed with MIT-TLO
- Validation (eyeglasses in 0.25 diopters)
 - 0.09 D : objective precision
 - ~ 0.5 D: subjective trials
 - 0.3 D: IRB approved wet-studies
- Awards
 - Google Invention Grant (\$40K)
 - MIT Deshpande Center Ignition Grant (\$50K)
 - Finalist in Development track of **MIT \$100K**
 - MIT Ideas #2 Award (\$5K)
 - Press



MIT IDEAS award

Acknowledgements



Tufts Medical Center

Clinical testing



VisionSpring



Centre for Vision
in the Developing World

Deployment



So that all may see
L V Prasad Eye Institute

Field testing

Potential Impact and Risks

- Science:
 - A range of eye-care solutions using phones
 - Cataract, lazy eye, diabetics
- Economic:
 - Hardware ‘app store’
 - Disruptive patient-centric-model
- **Risks**
 - **Patient-centric eye-devices not common**
 - **FDA/regulation delay**
 - **‘Simple’ tool, perceived low barrier to entry**



Health at Home



Body temperature



NETRA: Eye refractive errors



Blood pressure



Blood glucose



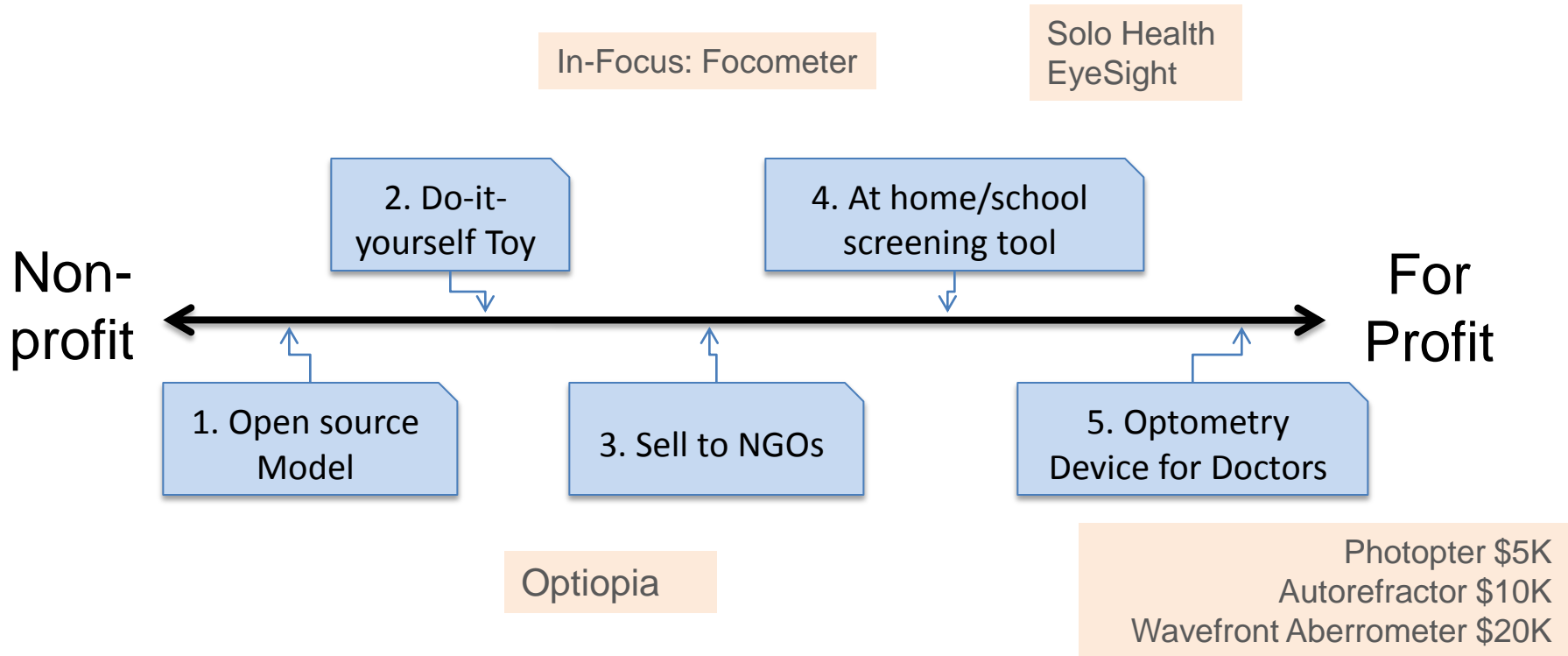
Blood oxygenation

Needs expert, Moving parts, Shining lasers

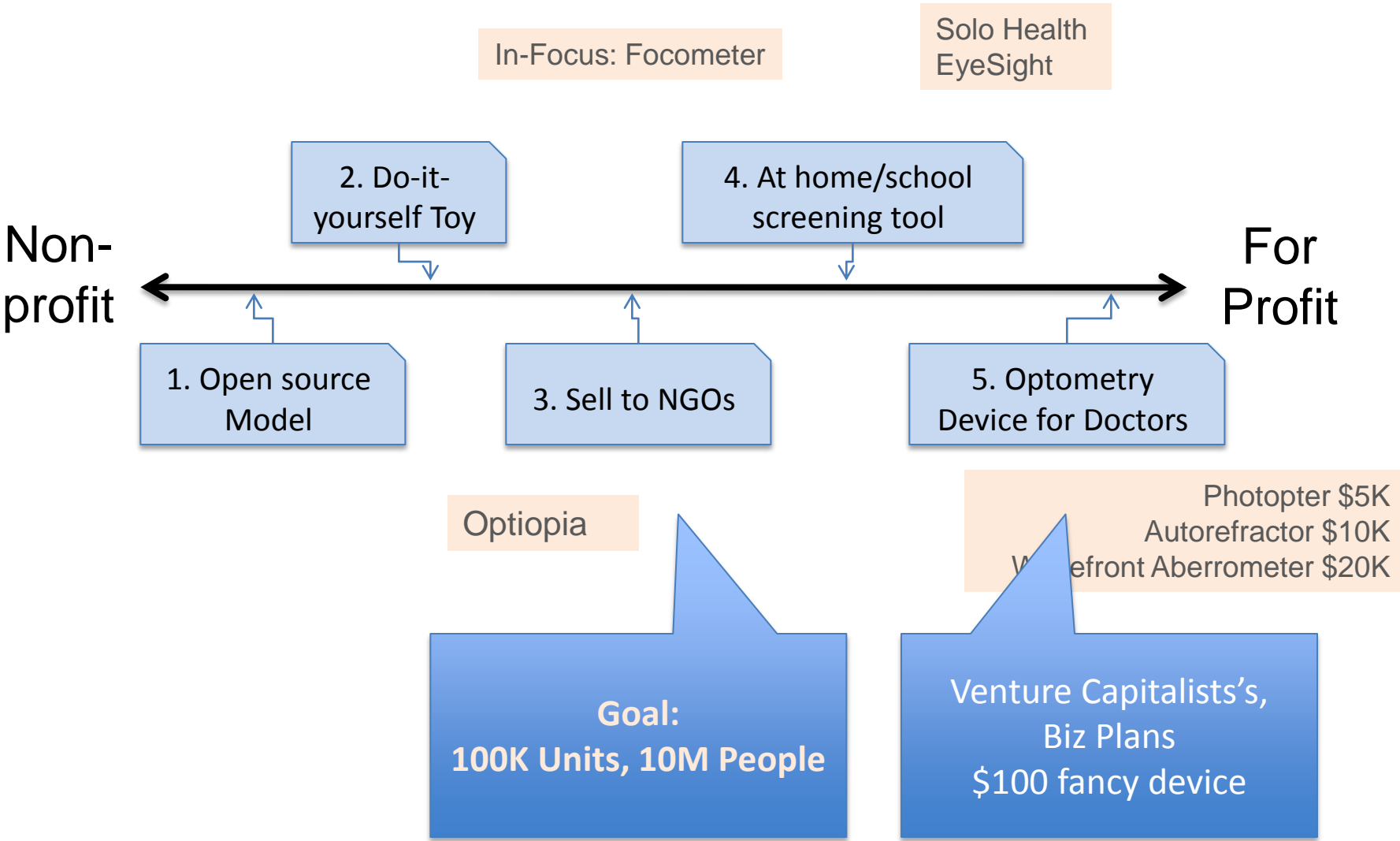
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Business Models



Business Models



NETRA: Vision Test on a Cell Phone

- Device without moving parts or lasers
- Myopia, Hyperopia, Astigmatism
- Thermometer for the eye

For Developing Counties

- 600 Million without corrective glasses
- \$1 cost, easy to deploy, free s/w,
- **EyeNetra.com**

